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POWER

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A Beneficent Governmental Activity

AMONG the mail that passes over my desk there came some time ago a pamphlet entitled "Why You Should Insulate Your Home."

It told how a properly insulated house saves fuel, resists fire, saves labor, deadens sound, is warm in winter, is cool in summer and has increased salability.

I naturally supposed that it was an advertisement of insulating building material, but there was nothing to identify it with any particular dealer or product.

But there was an announcement that it had been prepared by the Natural Resource Intelligence Service of the Department of the Interior for the Dominion Fuel Board.

It showed that if all the residential buildings in Canada were properly insulated against loss of heat, an annual saving of at least thirty million dollars would result.

For an average insulated house of six to eight rooms an annual saving of at least three tons of coal or its equivalent might be expected.

Almost simultaneously comes a comment in an industrial bulletin to the effect that research by the manufacturers of material to cut down the loss of heat through walls and roofs has demonstrated that the cost of insulating can be made up in a few years by the saving in fuel.

And it seemed to me that this was a beneficent type of activity for a governmental bureau, conserving the national resources, reducing the necessity for imports and saving money for its people.

There is an even greater saving to be effected in the adequate use of insulating material in power plants and industrial establishments. An estimate of this possible saving and directions as to how it can best be effected would be a useful product for one of our own governmental departments which are already getting out a lot of interesting and useful material that should be more generally known and more widely used.

F. R. Low

Statistics and Power Plants

PUBLICATION by the government in Washington of a booklet telling "How to Use Current Business Statistics" brings to mind the aid that can be derived from this source by power-plant executives. Business conditions at any given time, in conjunction with those that have gone before, give a fairly dependable indication of the trend for the immediate future. On the basis of such a forecast the activities of a power plant can be budgeted over some future period, and economies can be realized by contract purchases of coal and other supplies and by improved scheduling of additions, replacements and repairs.

One large hardware plant has done this with gratifying success. They study their own business in the light of the government's figures on general business. From this they lay out a schedule of manufacturing operations for a year ahead. Each month, on the basis of new information available, the schedule is revised, if necessary.

The plant engineer of this company has developed factors for each of his activities. By applying these factors to the scheduled plant output, he can readily keep his budget adjusted to fluctuations in the business. The result has been a marked saving in the cost of operating the power plant and an almost exact lining-up of power plant activities with manufacturing operations.

Here is one way in which alert engineers can profit from the government's statistical publications. As a guide post to business conditions of the near future this information is coming to be recognized as of great value.

Blading Troubles in Steam Turbines

STEAM-TURBINE blades have failed from time to time from a variety of causes. When high-temperature steam was first used, it was found that certain blading metals soon broke when subjected to these increased temperatures. The properties of the various metals are now better understood, and blade materials are available that will serve with the highest steam temperatures in use at present.

Little was known of the phenomena of fatigue and fatigue failures in the early days of steam-turbine construction. Undoubtedly, many of the accidents where blades were lost on the early turbines were due to these causes, although fatigue failures were practically unrecognized at the time. There is still much to be learned concerning the causes and extent of vibration in turbine blades which develop the repeated or alternating stresses that eventually lead to failure. Much has been done to lessen fatigue failures, such as the use of lashing wires, shrouds and improved forms of blades which taper from the thick shanks at the base to the thin tips. These have all been beneficial, but do not seem to have eliminated the trouble entirely.

Possibly, it will be necessary to carry out further research of the forces on turbine blades that set up stresses of high frequency, of methods of fastenings, and of the forms of blades themselves.

It has been noted in several cases that the blade failures first appear as cracks near the entrance edge of the blade. Sharp edges are used at the entrance and exit of blades with the object of securing high economy. This form appears to be very susceptible to fatigue failure, while smooth well-rounded edges seem less likely to crack. A study of stream flow of high-velocity steam may develop a rounded-edge form of blade which will have as high efficiency as at present, but will be less likely to crack from fatigue.

Much thought has been directed to the accelerating effect of corrosion on fatigue. Corrosion requires warmth, moisture and oxygen. The low-pressure stages of steam turbines, where most blade failures occur, are hot and the steam in these sections is wet. If boiler feed is not properly deaërated, there may be sufficient oxygen present to accelerate corrosion. Oxygen may leak in during idle periods. This corrosion would greatly accelerate fatigue failure. The remedy would appear to be to keep the casing free of oxygen at all times.

Are Binary-Vapor Systems the Next Forward Step?

PROGRESS in the generation of power has been extremely rapid during the last decade. Changes and improvements have come so fast that, in the endeavor to keep abreast, few engineers have the time or opportunity to meditate for long upon what new equipment and methods are likely to become standard by the end of the next decade.

However, there are those who, by the very nature of their work, are required so to study the future. One of these, a prominent engineer of Washington, D. C., recently remarked that the next step forward in the generation of power would see the general adoption of the binary-vapor system. Present work along this line he regarded as still experimental, for he did not feel that mercury would ever come into general use as one of the vapors, nor did he think diphenyl-oxide a sufficiently stable compound to meet the requirements of steady service.

The point is, and so he tells all his chemist friends, that the general realization of economies comparable to those realized from the mercury-steam combination awaits the discovery of a suitable material to use in combination with water in a dual system. And, since the chemists know of this, the desired fluid is quite likely to be available before many years have passed.

This engineer's forecast may be wide of the mark. So many other possibilities exist that may prove to be more advantageous than the generation system that uses two fluids. For the present, at least, the limits set by the properties of available construction materials seem to promise but slow development of higher temperatures than are now used. Higher pressures in a system using steam alone are now being used, as in the Benson boiler. The pulverized-coal engine is apparently being perfected. Various combinations of other industries with power generation to increase the over-all heat efficiency are being tried. Any one of these developments may prove more advantageous than the use of two fluids for power generation.

Whatever the outcome, the important thing is to see its advent sufficiently far ahead to be prepared. If binary-vapor power generation is the coming thing, engineers should be ready for it when it comes. In any case, it is worth while to keep abreast of progress and to see as far into the immediate future as the facts at hand will permit.

Seeing Is Believing

FOR many years motion picture films have been made to show various manufacturing processes, and several manufacturers have developed splendid films in their works. These have been shown here and there in schools and colleges and meetings of various organizations, and a number of organizations are engaged in collecting and distributing such material.

The latest development in this promising field is the University Film Foundation, whose plans are announced in the news pages of this issue. With the resources of Harvard University behind it, the Foundation, organized on a non-profit basis, should accomplish much in bringing to the teacher the assistance that the "movie" can render in reinforcing the spoken and printed word.

For setting forth the purely descriptive aspects of technical processes, the film presents many obvious advantages. While information so easy to take may excite the suspicion of the hard-boiled educator, it cannot be denied that there is much value to the student in seeing the wheels of industry go 'round. If he can visit plants and see the real thing, good, but if not, the film is a first-rate substitute. And sometimes an intelligently made film gives a better view than one could ordinarily obtain in the actual plant. And he can see it repeatedly if need be and under circumstances conducive to careful study. Slow-motion and fast-motion studies present great possibilities.

Power greets this new arrival cordially and hopes that it may grow into a position of high influence in the educational system of the country, not only in schools and colleges, but also in organizations such as the N.A.P.E., that are devoted to the continuing education of their members in the scientific arts that mean so much today.

The User Pays the Cost

UNTIL recently the discretion of the designing engineer was the chief guide in determining the size of brushes that should be used on rotating electrical machines. This unrestrained exercise of choice has led to thousands of sizes and styles of carbon brushes being adopted. Many of these need never have been brought into existence if a little thought had been given to following some set of standards. This situation has been made more involved by the hundreds of grades in which brushes are manufactured.

Even though initial steps have been taken toward standardizing brush dimensions and shunts, the present difficulties cannot be remedied for many years except where the user is willing to try to do something for himself. Under present conditions, with few exceptions, carbon brushes cannot be manufactured in quantities and the orders filled from stock, but must be produced as ordered. These orders may be as small as for two brushes. To obtain the best operating results, carbon brushes must be made to close tolerances, and to do this requires ten or more machine setups. It does not cost any more to make these machine adjustments for one hundred brushes than for one. Therefore, the unit cost of producing small quantities must be high.

This condition does not seem to be generally realized by purchasers of brushes. Even when they can be ordered in large numbers, the user is prone to order for individual machines instead of in quantities justified by the number of motors of a certain type and size in operation. When a user wants eight brushes of the same dimensions and insists upon handling the purchase as two separate orders of four each, standardization is going to have pretty hard sledding.

A careful survey in many plants will show opportunities for reducing the number of different brushes required to service the machines, and some plants have made such a survey with satisfactory results. Where brushes on two or more machines have the same cross-section but are slightly different in length, these have been adjusted to the same lengths with the same style of shunt. In other cases changes in brush-holders have been made to reduce the number required to service motors.

Any benefits coming from standardization must eventually revert to the user of the product. The producer of the product must make a profit if he is to stay in business, which means that the user must pay the cost of the product plus a profit, no matter what that cost may be. This is a simple law of economics that applies to carbon brushes as it does to everything else.

Imagine the Savings!

IMAGINE what a difference it would make in the efficiency and economy of the machine drives in some industrial plants if the gearing were as well selected and maintained as the gearing on the turbines in the power plant. Often, the geared drives used with production equipment seem to have been selected with regard only to the attainment of the correct machine speed. Economy of operation and maintenance are too often neglected.

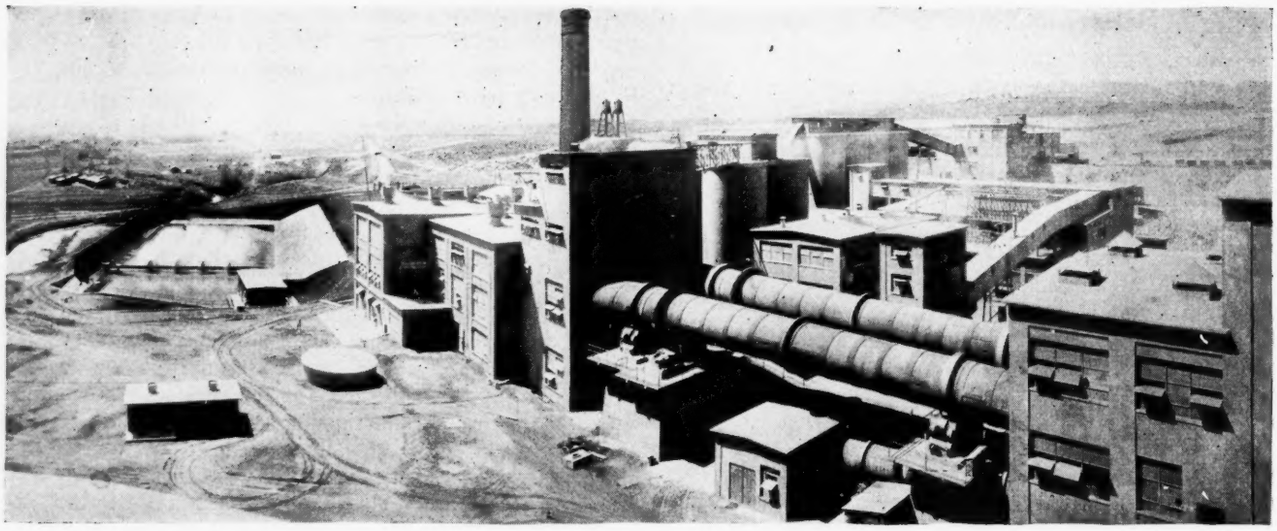
Of course, the production departments of plants where such poor practice is found will argue that suitable gearing costs too much. The idea will be advanced that it is better to endure losses in power and high cost of maintenance than to run up the fixed charges by being too particular about the gears. This view, however, takes no account of the losses in production volume that follow the use of misapplied, unsuitable, but cheap gearing.

When the management of plants now permitting such wasteful practices realizes the waste that is going on, changes will be made. The selection and maintenance of gearing in the production department will be put in charge of the power engineer, who by training and experience is fitted to carry out the most economical procedure. And when this step is taken, imagine the savings that will be made!

Are Boiler Sales an Index of Power Activity?

RECENT figures given out by the Department of Commerce show that the sales of steel boilers, as to both number and capacity, are again on the rise. Although the total for the first six months of 1928 is some three per cent behind a like period in 1927, each month since March, 1928, has shown an improvement, June, 1928, being four and a half per cent above June, 1927, in total sales.

Whether or not this means a definite upturn for business conditions in the power field, can hardly be decided on the slight information so far available. At any rate a trend toward improvement is indicated. Business in boilers for the remaining months of the year will be well worth watching.



Panorama of Colorado Portland Cement Company with kilns and coolers in foreground

Surplus Power From Waste Heat
Sold to Central Station

By Paul C. Van Zandt

Chief Engineer, Colorado Portland Cement Company, Boettcher, Colo.

SEVEN miles northwest of Fort Collins, at Boettcher, Colo., is the new 3,500-barrel, dry-process plant of the Colorado Portland Cement Company. The raw materials are calcareous shales quarried immediately adjacent to the plant, loaded by steam and electric shovels into cars, and transported to the plant over a short industrial railway. The process of manufacture involves crushing the rock, drying and grinding it to a powder, of which over 90 per cent passes through a 200-mesh screen, calcining to portland cement clinker in rotary kilns, cooling and grinding the clinker to finish cement, storing and packing for shipment.

Power for all these operations is supplied by the waste heat leaving the rotary kilns, and no fuel is used directly for power generation. The waste heat plant has proved to be of greater efficiency than any other in the cement industry, within the writer's knowledge.

Since all the heat used in generating steam comes from the calcining equipment, a brief description may be of interest. The two rotary kilns are steel cylinders 11 ft. in diameter by 175 ft. long, set inclined one-half inch to the foot and rotated on rollers in from one and one-half to five minutes per revolution. The shell is lined throughout with firebrick 9 in. thick, making the net inside diameter 9½ ft. The dry powdered limestone and shale is fed into the upper end in a constant stream through an inclined spout and gradually finds its way to the discharge end from the rotation of the shell. Natural gas is burned in the lower end, which is closed by a hood, open on the bottom to permit the white-hot clinker to discharge into a spout entering the upper end of a cooler. Like the kiln, the cooler is a cylindrical shell 7½ ft. in diameter by 70 ft. long, lined for 20 ft. from the upper end with vitrified paving blocks and provided with lifters that shower the clinker across the shell to expose it to the cooling air blown through from the lower end by a fan. The cooled clinker leaves the cooler through a hood discharging into a conveyor carrying it to the grinding mills.

Air blown into the cooler by the fan takes up the heat from the clinker and also some fine sharp clinker dust. A small portion of this air is blown into the kiln through the discharge spout, but the greater portion enters the dust chamber, where the clinker dust settles out. A hot-air fan drawing from this chamber, forces the hot air through the gas carburetor, where it is mixed thoroughly with the gas, and from there into the kiln, where the mixture ignites. The amount of combustion air required by the gas is determined by the differential pressure between the gas in the manifold and the air in the pipe and is regulated by a damper. The excess air in the dust chamber is vented through a stack to the atmosphere.

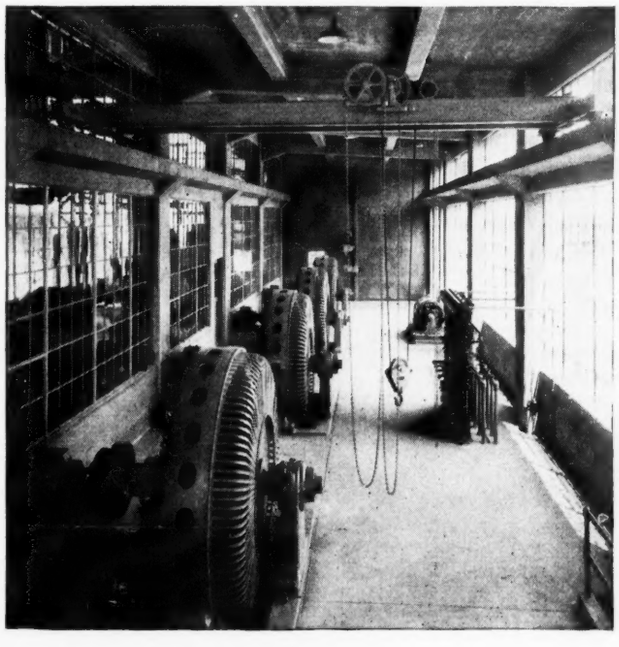
Air leaving the clinker cooler is at a temperature of 400 to 500 deg. F., and in the burning zone of the kiln the temperature ranges from 2,700 to 2,800 deg. F. The gases leave the kiln at the upper end at temperatures of 1,400 to 1,500 deg. F. Passing down through slots in an arch into a common flue, the gases from the two kilns

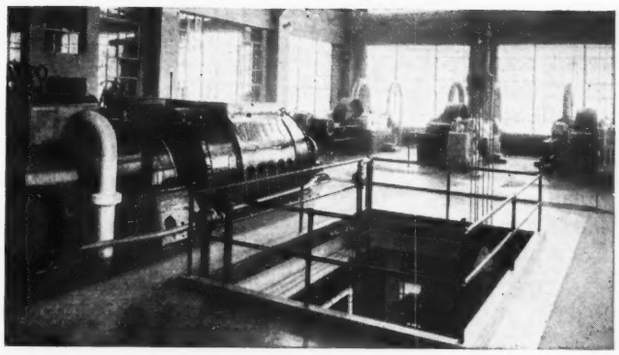
are distributed to the two boilers. By induced-draft fans the gases are drawn through the boilers and economizers, leaving the latter at a temperature of about 325 deg. F., and are forced into a duct leading to Cottrell electric precipitation chambers which drop the dust and pass the gases to a 12x150-ft. concrete chimney.

The Cottrell installation consists of two two-unit precipitators, each unit having two sections of fifteen ducts each, making a total of eight sections for the plant. The precipitators are of the graded-resistance electrode type consisting of chambers in which reinforced concrete plates 6½ ft. wide and 12 ft. deep, are hung along the passage of the gases. They are spaced approximately 6 in. apart. The gases flow through the chamber between these plates. Between each pair of plates is a discharge electrode consisting of iron wires hung vertically from porcelain insulators and held in position by a heavy sash weight attached to the lower end of each wire. These wires are attached to the positive pole of a spark gap rectifier driven by a synchronous motor. The electric current for this rectifier is transformed from the plant voltage of 2,300 volts in single-phase transformers to 40,000 to 60,000 volts, so that the precipitator is charged with this high-voltage interrupted direct current which charges the particles of dust passing through, causing them to separate from the gas and attach to the concrete plates, from which they drop into a hopper and are returned to the process. Gases leaving the stack are practically free from dust and also from smoke.

Although natural gas is the fuel now used in the kilns, for the first two months the plant was operated on powdered coal, and is therefore equipped to burn either fuel. The coal plant consists of one five-roller super-mill without coal drier, complete with air separators, fans, etc. The coal may be delivered to the plant through a track hopper to an elevator which discharges it to a feed bin ahead of the mill. It is drawn from this feed bin over a scale from which it drops into the feed hoppers of the mill. The pulverized coal is elevated by the air fan included with the mill into an air separator located above the coal feed bins. From these bins the

Motor room of grinding mill with five 600-hp. clutch-type synchronous motors





Turbine room containing one 5,000-kw. turbine generator and three 1,090-c.f.m. motor-driven air compressors

powdered coal is drawn by screw conveyor feeders and fed by them into the fuel pipe through which it is blown into the kiln. During the two months' operation on coal and the subsequent operation on gas, it has been interesting to notice that the B.t.u. required to make a barrel of cement (not counting ground storage loss of coal) was almost identical with either fuel, but slightly in favor of the gas.

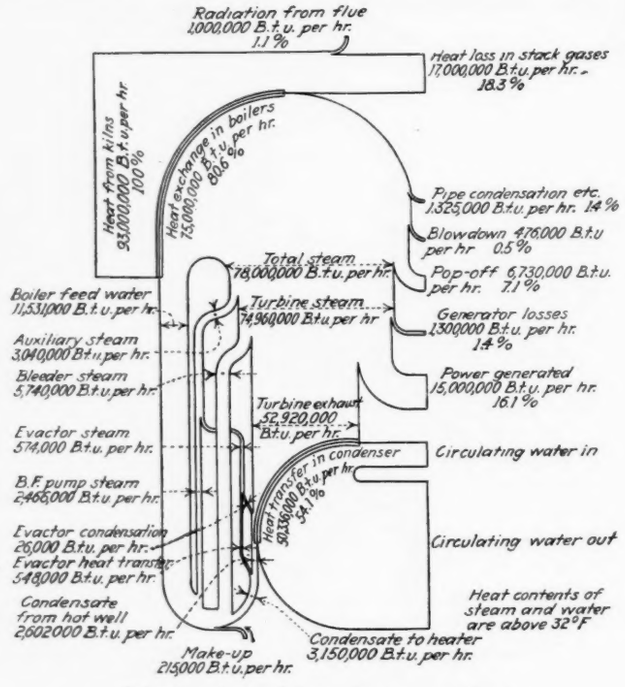
Three-phase 60-cycle current is generated at 2,300 volts and the plant is tied in with the public service company's system through a 1,000-kva. transformer bank and a 13,000-volt line to Fort Collins. The total connected power load is 8,045 hp., of which 1,400 hp. is in small 440-volt motors under 40 hp. The remainder of the load, or 6,645 hp., is made up of motors ranging from 40 to 600 hp. and designed for 2,200 volts. Approximately 3,300 hp. is in synchronous motors, including the five 600-hp. clutch-type motors that drive the large grinders. The power factor is maintained at 100 per cent. The average plant load is 3,612 kw., and the average production of power in the waste-heat plant is 4,400 kw., the surplus being sold to the public service company.

A peculiarity of the waste-heat plant is the fact that the steam generated in the boilers has no close relation to the power demands of the plant, and goes on independently of the requirements of the turbine. For this reason the connection to an outside source of power is valuable both as a means of starting the plant and operating other departments when the kilns are down temporarily, and also as a means of absorbing excess waste-heat power over and above the requirements of the plant. The efficiency of the plant has resulted in a constant flow of this "dump power" into the public service lines during normal operation, and even has been a disadvantage when power beyond the 1,000-kva. outlet is generated in the form of steam that must be blown from the safety valves. At times it actually has been an advantage to run the plant as wastefully as possible to avoid this loss of steam to the atmosphere during a period when some of the grinding machines were down temporarily.

With this problem of running a waste-heat plant inefficiently to avoid blowing off steam when its generation is in excess of requirements, the writer has had previous experience. Because the noise becomes a nuisance silencers sometimes are placed on the safety valves. The loss of makeup water puts an overload on the water softeners and also on the blowdown valves to keep down concentration in the boilers. Some plants have installed single-stage evaporators to utilize this excess steam in making distilled feed water. Where the water supply

is pure, as is the case at Boettcher, this is not advantageous, but the loss of costly water in a country where water is scarce is an item. The best solution seems to be to provide an outlet for "dump power" to at least two-thirds the capacity of the plant. Further economies in the kiln fuel consumption eventually will remove the trouble, but the kiln economies at Boettcher are already as good as possible in the present stage of the art.

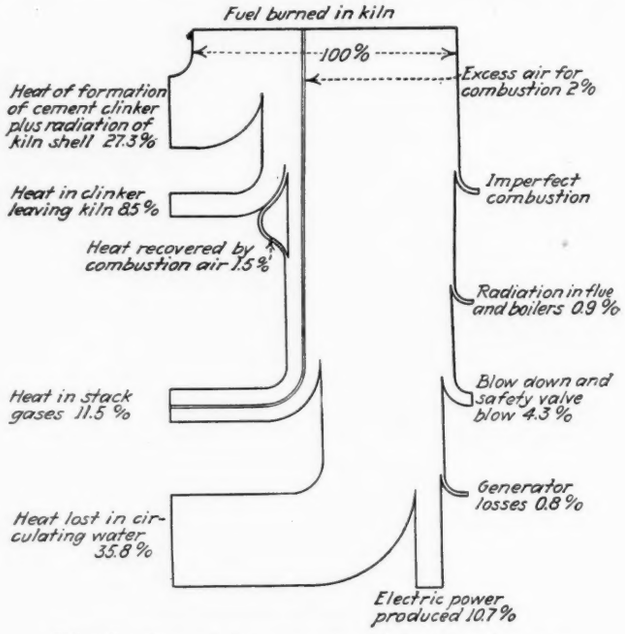
The spray pond serves the double purpose of cooling and storing condenser water. It was excavated in a



Distribution of heat in power plant

natural depression adjacent to the irrigation ditch running by the plant, so that ditch water can be diverted into the pond through the condenser and back into the ditch on the downstream side through an extension of the spray header. When operating on ditch water, the valve on this extension is open to the ditch, and since there is then no pressure in the header, the sprays do not function and there is no consumption of water by evaporation. The temperature of the ditch water averages 50 deg. F. or less and by its passage through the condenser is raised only one degree.

When the ditch is not in use, it is shut off from the pond by closing the inlet and outlet gates and the sprays automatically function. The makeup for the pond and the plant is obtained from the Poudre River two miles south, through a remote-controlled pumping plant at the river. The company owns a share of water in the irrigation ditch and the rights to 10,000 cu.ft. of water yearly from the river. The excess over plant requirements is sold for irrigation. The pond has a capacity of 2,000,000 gal. To supply makeup water during an emergency, a pumping plant has been installed on an

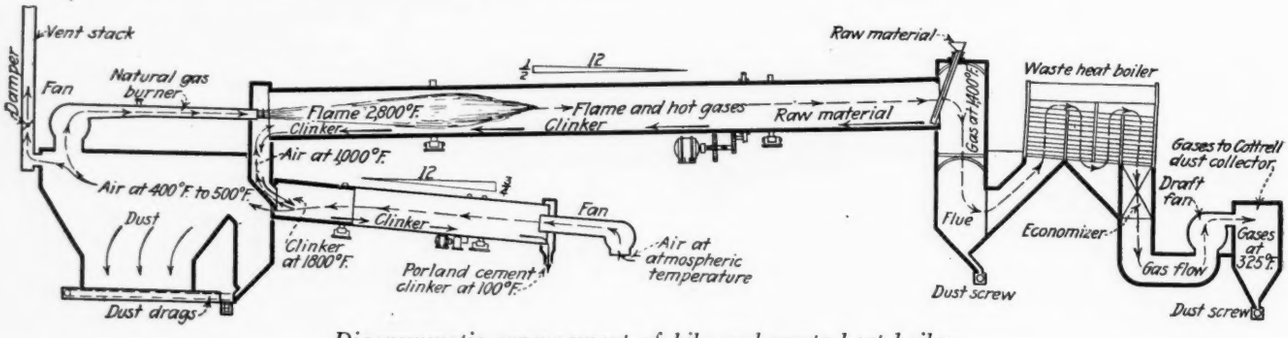


Distribution of heat produced by burning gas in cement kiln

irrigation reservoir, Curtis Lake, but as this water is hard, it is used only in case of necessity.

In a waste-heat plant like the one under description, the cost of power per kilowatt-hour is exceedingly low, amounting to a few mills, including interest and depreciation, which constitute the bulk of the cost.

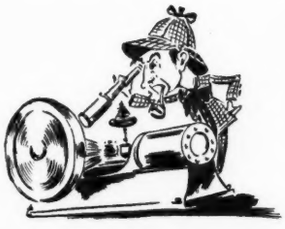
The cost of the "dump power" is too small to admit of accurate calculation, as all the items of cost are fixed —namely, labor, supplies, interest and depreciation— and are figured against a barrel of cement produced, crediting the barrel cost with the revenue from the power sold. Likewise, as long as there is excess power, the amount of power used in the process does not affect the cost so much, and the necessity of cutting the kilowatt-hours per barrel to a minimum does not exist to the same extent as it does where power is purchased at a relatively high cost. Another interesting feature in connection with the use of waste heat is, for example, the selection of equipment that is exceedingly economical for cement manufacture, except that it requires more power, which could not be used where the power cost per unit is high.



Diagrammatic arrangement of kiln and waste-heat boiler

Solving the Mystery of an Engine Pound

By Frank P. MacNeil



MANY of the operating difficulties experienced in a steam plant could be overcome if the engineer understood how to use tools that are available to those who are willing to accept the aid of the theorist.

In our plant a 17x32x24-in. high-speed non-releasing tandem Corliss engine turning 184 revolutions had been growing noisy of late, and after every known remedy had been tried without effect, it was decided that the engine's low-pressure piston was loose.

The mechanical superintendent gathered up his gangs of machinists, pipefitters, riggers, diggers and roustabouts Saturday morning until there was such a mob about that it was difficult to discover the engine in the mass of squirming humanity. The high-pressure cylinder was pulled back and the low-pressure piston nut was tried. They did manage to get something on it, but nothing like what was expected. As a matter of fact they only stretched the rod at the threads. Everything was put together that night, and a short trial run was made without load, to see how the engine acted. It appeared to run better, so Monday morning it was started up and its regular load put on.

Now it happened that about the same time that the engine began to give trouble, the demand for process steam had grown to such proportions that the water tenders found it unsafe to carry less than three gages of water in the water-tube boilers, as a sudden demand for process steam would rob the boilers of their water before the tenders could get the feed pumps speeded up.

Salt river water was used for the barometric condensers, and pumps that once could deliver a plentiful supply to the condensers were now inadequate to supply enough for the condensers and the process work, so the vacuum had been gradually dropping back on all condensing engines.

In a few days the engine was as noisy as ever, and it was decided the low-pressure nut had loosened again; this meant the engine must be opened up a second time.

One of the watch engineers was not satisfied that a loose nut was what ailed the engine. He had been keeping his eyes open and doing considerable thinking. He noticed that the engine took spells of making noise and then would run quietly for a while. There was a Venturi meter on the feed line, and he noticed that lately there were times when the demand for steam reached 110,000 lb. an hour, a figure that had never before been approached.

One day the load was very heavy and condensing water was scarce. The high-speed Corliss had been carrying a 26-in. vacuum; this day it went back to 19 in. and the engine was starting to pound heavily. He was convinced that wet steam was the cause of all the trouble, so the first thing to do was to get the vacuum restored to 26 in. His object was to decrease the steam consumption and thereby decrease the amount of water that must pass into the engine with the steam. He reasoned that if the engine used 15 lb. of steam per horsepower-hour and there was 10 per cent moisture in the steam, $300 \times 15 \times 0.10 = 450$ lb. of water entered the engine when the engine was delivering 300 horsepower.

The piston speed, 736 ft. per min., was a factor that would not allow much heat exchange per revolution, so re-evaporation could not be considered as of much influence in results. The water carried in, besides being a loss, also served to encourage condensation and thus compounded the difficulty.

When the vacuum was restored to 26 in., the engine ran much better, for the lower vacuum increased the engine's efficiency and reduced the amount of steam consumed per hour. This, in turn, reduced the amount of water entering the cylinder.

It now remained to convince the chief engineer that if the steam was dry, they could forget the loose piston. The Venturi meter was a great help in locating the exact cause of all the trouble. It was noticed that at noon, when the big demand for steam subsided, the engine pounded the most. This was puzzling, for it was reasoned that high rates of evaporation promoted priming.

Here was a case in the reverse order, so the engineer concluded that another cause was operating to produce this result. It was not from a light load, for the engine ran at full capacity during the noon hour; it was out in the fireroom where the trouble was coming from, but the engineer had to be sure he could put his finger on the spot before he voiced his opinion. He began by watching the Venturi meter and the water level in the different boilers. He contrived to have high water in different boilers when a high demand for steam dropped off. First, he picked out the boiler that had been longest without cleaning, and then went through the lot of them. There were two that were particularly good steamers, and as compound was pumped into the boilers each day he could notice it in the glasses of these boilers. So when their turn came they received extra vigilance. His reasoning was correct; one of them was a veritable geyser.

But why did not the engine get the priming all the time? Examination of the steam piping disclosed the reason, for the process steam line was more direct. The high-speed Corliss was the greediest thing for steam in the engine room, so it got all the priming when there was a lull in the demand for steam elsewhere.

Efficiency of 89 Per Cent with CALUMET POWDERED COAL BOILER*

By A. D. Bailey and W. H. Jensen

DEVELOPMENT of pulverized fuel firing has been observed by the Commonwealth Edison Company with conservative interest, as for the plants of the company it was considered that this method of firing involved more the economic problem as a whole, rather than the thermal economy. Experience and data published by other companies always have been felt insufficient as a guide in our problems, owing to the special characteristics of our fuel and because the plants were in or near thickly populated communities, so that the elimination of dust would be a serious factor.

For these special reasons an experimental installation was decided upon, the experiment involving both types of firing, namely, the bin and feeder system and the unit or direct-fired system, applied to different types of steam generating equipment. The bin and feeder system was put into regular operation at the Calumet Station, Nov. 8, 1926. Although this installation has been given previous publicity[1] in the technical press, a brief review of the equipment will be of value when interpreting the operating results obtained.

WITH only 5,940 sq.ft. of surface in the boiler proper a maximum output of 290,000 lb. of steam per hour and an over-all efficiency of 89 per cent are obtained. The installation has double the output of 15,000-sq.ft. stoker-fired boilers in same plant, occupies but 50 per cent more space and has but one-quarter the furnace maintenance cost. Over 90 per cent of ash passing to the stack is eliminated by a gas washer.

Approximately 5,940 sq.ft. of heating surface is contained in a cross-drum boiler 40 sections wide, the sections being seven tubes high and built up of 3¼-in. tubes, 17 ft. long. The drum, which is 32 ft. 5 in. long and 48 in. in diameter, was built for a working pressure of 375 lb. The superheater is three-pass, with 3,000 sq.ft. of surface installed, the ratio of superheating surface to heating surface being 1 to 2. The economizer ratio is 1½ to 1. With 1,960 tubes, 2½ in. in diameter, the air heater has 41,700 sq. ft. of external surface. The induced-draft fan has a capacity of 144,000 cu.ft. of air at 300 deg. F. and 12 in. static pressure. It is driven by a 500-hp. two-speed motor. There are two forced-draft fans, each of 58,000 cu.ft. capacity, with the air at 70 deg. F. and 4 in. static pressure. In each case the drive is a 100-hp. motor.

Fuel preparation equipment is of the storage system type. The raw coal is passed through a Bradford breaker on its way to the overhead bunker, from which it passes through a valve to the Fuller-Randolph drier located directly under the bunker outlet. The coal is dried with preheated air that can be tempered. This air is supplied through two ducts off the main air ducts and is exhausted by means of an exhauster fan, to two cyclones which vent to the atmosphere, the fine dust dropping out and down the chute to the mill.

The coal passes through the drier to a drag feeder, discharging into a chute, passing over a magnet and into the mill. The mill is a 70-in. Fuller-Lehigh, screen type having a capacity of 15 tons per hour. It is driven at 125 r.p.m. by a 300-hp. motor. The grinding element consists of a grinding ring in which four 15-in., 500-lb. steel balls roll. Sizing is determined by the mesh of the screen that is used.

From the mill the pulverized coal is discharged into a hopper above the Fuller-Kinyon pump, the hopper being vented to the exhauster fan suction. Through a 6-in. transport line the pump delivers the coal to the boiler bins. The height of the coal in the bins is indicated on a control board near the mill and also on the main control board of the boiler.

Coal is fed through Bailey pulverized-coal air-operated gates by gravity from the bin to the two coal-weighing hoppers, from which the coal goes to the feeder bins and then into the Bailey feeders. From the feeder the coal drops by gravity into the stream of primary air from the fan, which blows it into the furnace through what are now called Calumet burners. There are four feeders, each supplying two burners, making a total of eight burners for the furnace. Each feeder has a maximum capacity of 10,000 lb. per hour.

*Paper presented before the Western Society of Engineers, Chicago, Feb. 20, 1928.

[1]For preliminary description of this installation, see *Power*, April 5, 1927.

Both the induced- and forced-draft fans are above the boiler. The forced-draft fans, taking air at room temperature, discharge it through the preheater. The heated air is carried to the front of the boiler by means of two ducts, one on each side of the boiler, from which the secondary and drier air is taken and also the air that is necessary to heat the primary air to the desired temperature.

On the control board are the draft and pressure gages, feeder speed indicator, flow meter and temperature

3. If primary air fan goes down, feeders and forced draft go out.

The drag conveyor, fuel pump and pulverizer are also interlocked so that there is no chance of blocking the system with coal. If the drag conveyor stops the mill will stop, if the pump stops the mill and drag conveyor will stop, and if the mill stops the drag conveyor will stop.

As to results, this unit has produced 290,000 lb. of steam per hour for a period of four hours, which means a heat liberation of 34,000 B.t.u. per cu.ft. of furnace

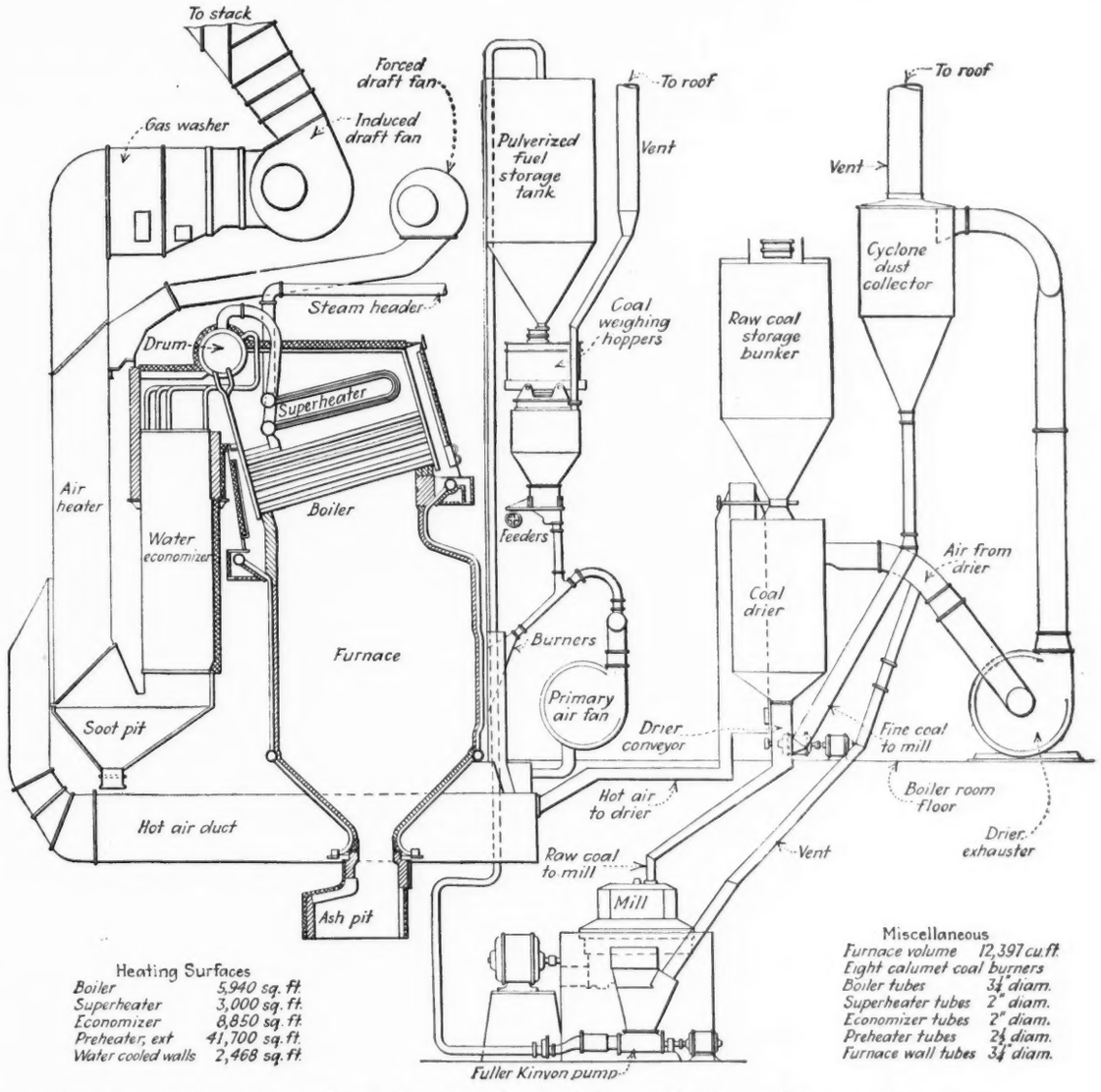


Fig. 1—Diagram of pulverized-coal installation, bin and feeder type, at Calumet station

recorders. On this board are also mounted all the motor controls, the Bailey combustion control drum switch and the handwheel for control of feeder speeds through a rheostat.

Electrical interlocks are provided on the different parts of the equipment so there can be no chance of a fireman starting up wrong or of explosive mixtures in case some part of the equipment fails. Interlock combinations are as follows:

1. If forced-draft fans go down, feeders trip out.
2. If induced-draft fan goes down, feeders and forced draft go out.

volume per hour. Of our 15,000-sq.ft. stoker-fired boilers the maximum output approximates 145,000 lb. per hour. Including all auxiliaries, the pulverized-coal unit occupies 50 per cent more space than the stoker-fired boiler.

The boiler is operated for 15 to 16 hours daily except on Sundays. At 10:30 p.m. the feeders and fans are shut down and the dampers closed. The unit is held over until 7 a.m., at which time the fans are started, the fire lighted and the boiler is delivering 100,000 lb. of steam in not more than ten minutes. Over the idle period the pressure drop is from 100 to 150 lb. From a

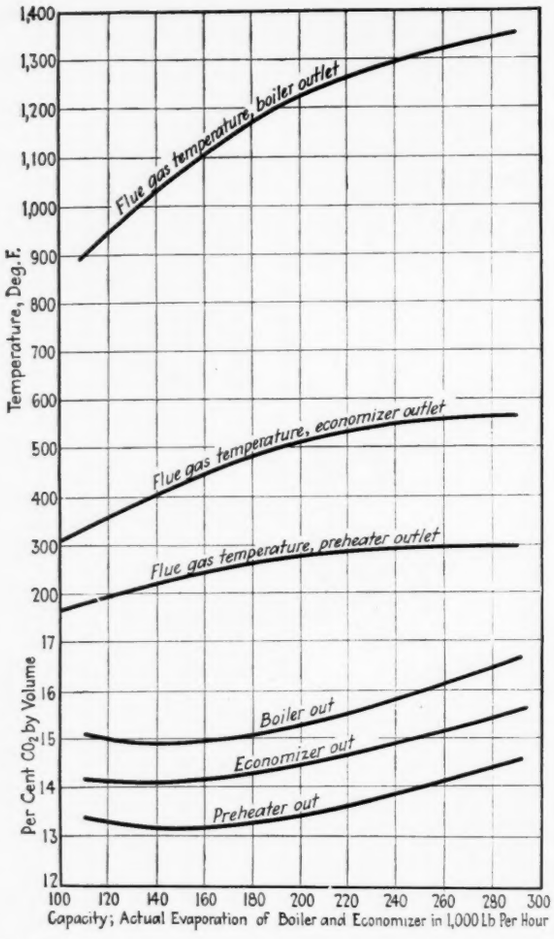

Flue gas temperature, boiler outlet
Flue gas temperature, economizer outlet
Flue gas temperature, preheater outlet
Boiler out
Economizer out
Preheater out
Temperature, Deg. F.
Per Cent CO_2 by Volume
Capacity; Actual Evaporation of Boiler and Economizer in 1,000 Lb Per Hour

Fig. 2—CO_2 percentages and flue-gas temperatures at different capacities

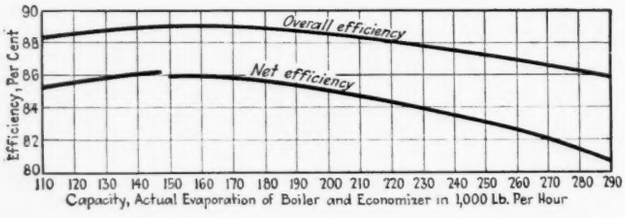

Overall efficiency
Net efficiency
Efficiency, Per Cent
Capacity, Actual Evaporation of Boiler and Economizer in 1,000 Lb. Per Hour

Fig. 3—Over-all and net efficiencies

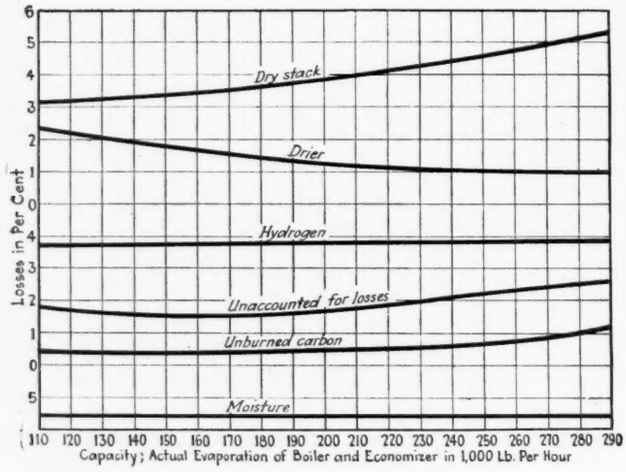


Fig. 4—Accounted- and unaccounted-for losses

cold condition the unit has been brought in on the line in thirty minutes. It usually takes from 1 to 1½ hours to do this with a stoker-fired boiler. Such performances appeal to an operator, especially upon sudden demands for steam.

Tubes in the boiler, economizer and preheater rapidly become coated with fine ash, which is blown off readily with the usual steam blower. Some slag collects on the lower row of tubes, but so far has not caused any serious plugging and, if not allowed to build up too heavily, is fairly easy to remove with a hand lance using air.

For cleaning the preheater a special blower unit designed to put a jet of steam into each tube, has proved satisfactory. The blowers on the entire unit are operated once each day, each element being revolved twice.

Unit Is Not Fully Automatic

Although the unit is equipped with a combustion control system, it is not fully automatic inasmuch as the capacity is regulated manually. The control has a drum switch with five positions for push-button control. In the first, second and third positions the push buttons are available to increase or decrease the rate of feeding of fuel or air, each entirely independent of the rest in accordance with which one of the three drum-switch positions is selected. In the No. 4 position both the induced and forced draft may be increased or decreased by push button with the forced draft being readjusted at the same time through furnace draft demands. In the No. 5 position both air and fuel to the boiler may be increased or decreased together and in approximately the right proportions, with the induced draft being automatically readjusted if necessary by the steam-flow or air-flow relation, and the forced draft likewise readjusted if necessary by furnace draft conditions. In other words, once the quantity of fuel has been set, the quantity of air needed is automatically set by the control.

For most of the 16-hour period each day the boiler is operated as a base-load unit, with an average output of 150,000 lb. of steam per hour, but in case of some sudden demand for steam, we always call upon this unit for 50,000 to 75,000 lb. more, because it is so easily obtained.

Forty per Cent of Ash Found in the Pits Under the Boilers

Tests have shown that of the ash from pulverized coal 40 per cent is found in the pits under the boiler, economizer and air heater and 60 per cent is carried along with the flue gases. The ash, largely in dust form, that otherwise would be carried out of the stack, is eliminated by a gas washer or scrubber ahead of the induced-draft fan, which is practically the same type as used for cleaning air for generators. This particular washer requires from 500 to 800 gal. of water per minute, and eliminates 90 to 95 per cent of the dust.

Use of the washer introduces a corrosion problem, so that we are trying different metals to determine which will require the least amount of maintenance. As an offset to some of the cost of maintenance we get an additional induced-draft fan capacity for high ratings, because of handling colder gas.

Ash that collects in the ashpit proper is usually in the form of pieces of slag that drop off of the water-cooled floor and from the side walls. Some dust is caught in the pits under the economizer and air heater. This is flushed out with water directly into a railroad car, into which the main ashpit material has been dumped.

Notwithstanding the low fusion temperature of Kincaid coal ash, anticipated slag difficulties have not materialized. On the other hand, more trouble has been experienced in disposing of slag from Perry County, Kentucky, coal, because it cannot be melted and made to run into the pit, as has been done with Kincaid ash. The slag collects on the rear floor, attaching itself to the rear wall, so that, whenever the boiler has been down, it has been necessary for men to go into the furnace and break up the slag by hand work, before it would drop into the pit.

Furnace Maintenance

The item of furnace maintenance has been small owing to the small amount of brickwork exposed to the heat of the furnace. Per ton of coal burned maintenance of the furnace has cost about one-quarter of that for the

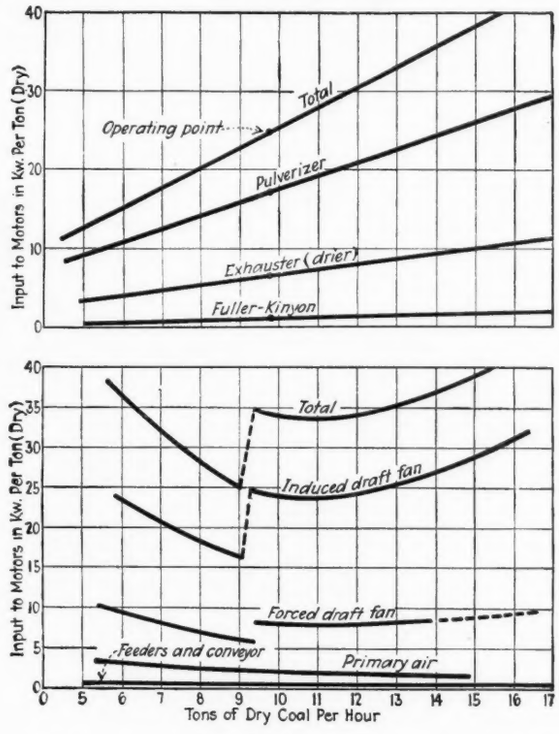


Fig. 5—Power for coal preparation and boiler auxiliaries

stoker-fired boilers. The Bailey walls have required the replacement of only 30 blocks, and this was at a place where the flame from the end burner impinged directly upon the blocks. This particular burner was only 2 ft. from the side wall, and it has been found since that about 3 ft. should be the minimum distance.

Entering the drier, the coal has an average moisture of 14½ per cent, of which the drier removes approximately 4½ per cent. The grinding process removes an additional 1 or 2 per cent, leaving from 8 to 9 per cent moisture in the coal as fired.

As previously stated, the coal is pulverized in a ball mill. After 350 to 400 hours of grinding, the balls, becoming egg-shaped, begin to slide instead of roll and have to be replaced. This service represents, roughly, 1,000 tons of ground coal per ball. With Kentucky coal from 3 to 3½ times longer service was obtained from a set of balls. Approximately 3,000 to 3,500 tons of coal was ground per ball. It is apparent that Kincaid coal is much harder to grind than might be expected, owing mainly to the character of the ash.

As sufficient data have not been collected on which to base definite conclusions, it was not considered advisable to give fuel preparation costs, but in the accompanying curves the performance data, efficiencies and power requirements may be of interest. The curves are self-explanatory. They show the results of tests, using Perry County, Kentucky, coal.

Slushy Brine Broke the Pump

By F. P. MacNeil

THINGS were running along quietly one morning in the engine room of a large cold-storage warehouse, when the engineer thought he could detect a variation in the sound of a compressor. A glance at the suction gage told him that his ears were good, for the suction pressure was just starting in to drop.

As the plant was electrically driven, there were not many seconds that could be spared in speculation as to where the trouble lay; ten seconds had now scarcely elapsed and the suction pressure was already only one-half the usual value. So the engineer shut the compressor down rather than let the coolers freeze up.

There were Venturi meters on the brine mains and inspection showed that one main, which had been delivering over 1,000 gal. a few minutes before, was now at a standstill. The motor-driven centrifugal supplying this main was running all right so far as outward appearances were concerned, but the needle of the gage on the discharge of this pump had gone back to zero when it should have been standing at 95 lb. A spare pump was quickly put on the line, and the Venturi needle climbed up to its old mark. Then the compressor was put back to work and a six-minute shutdown recorded in the log.

When the top of the pump casing was lifted, we found the shaft broken off square with the hub face of the impeller. Now what caused this? Crystallization? No, it was a clean white break of fine-grained metal.

Lately, the brine had been becoming low in gravity and the day gang were getting more fresh water into the system than calcium. The net result was that the brine froze at the tank temperature and got slushy. Something had to go when the pump tried to handle slush at the high speed at which they were running, and the shaft was the weakest part.

Power Enchained

Sometimes power, frequently pictured as the slave of mankind, is literally bound in chains. Chains and sprocket wheels are used to transmit a lot of power, and at the point of application severe-service conditions frequently lead to the choice of the cast-tooth sprocket drive. In next week's issue Charles Weiss will show how to select such drives to suit the job.

They Still P
in the A

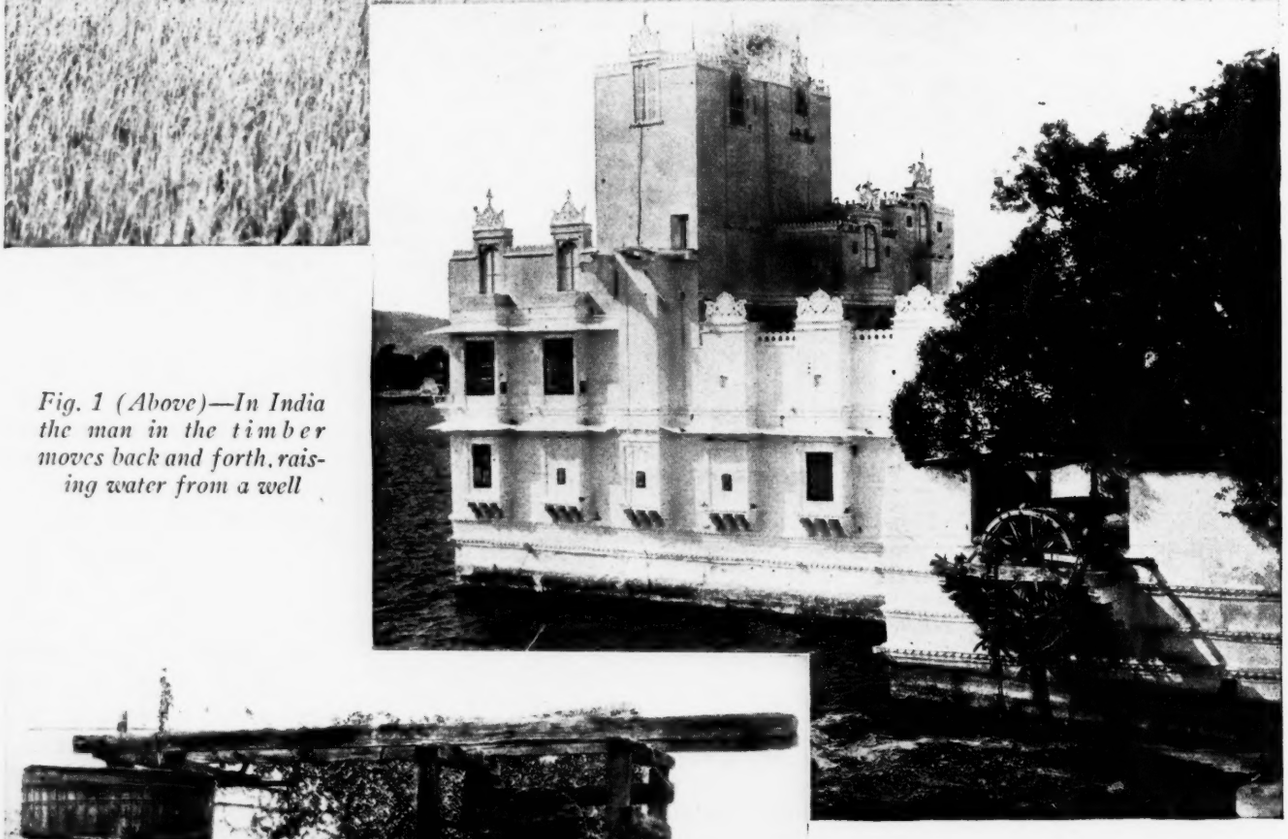


Fig. 1 (Above)—In India the man in the timber moves back and forth, raising water from a well

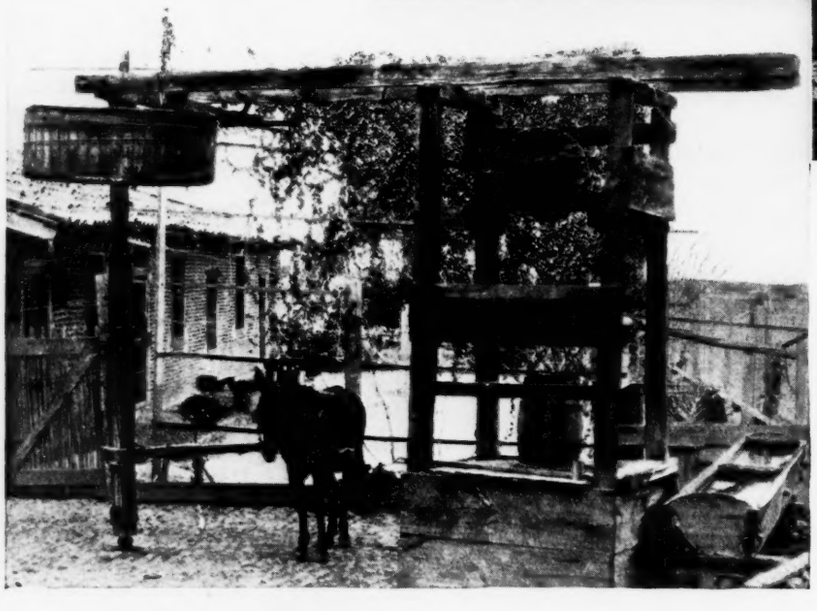


Fig. 2 (Above)—The sakich used to irrigate a garden on Jagmander Isle, India

Fig. 3 (Left)—A burro irrigation plant in Mexico

ll Pump he Ancient Ways

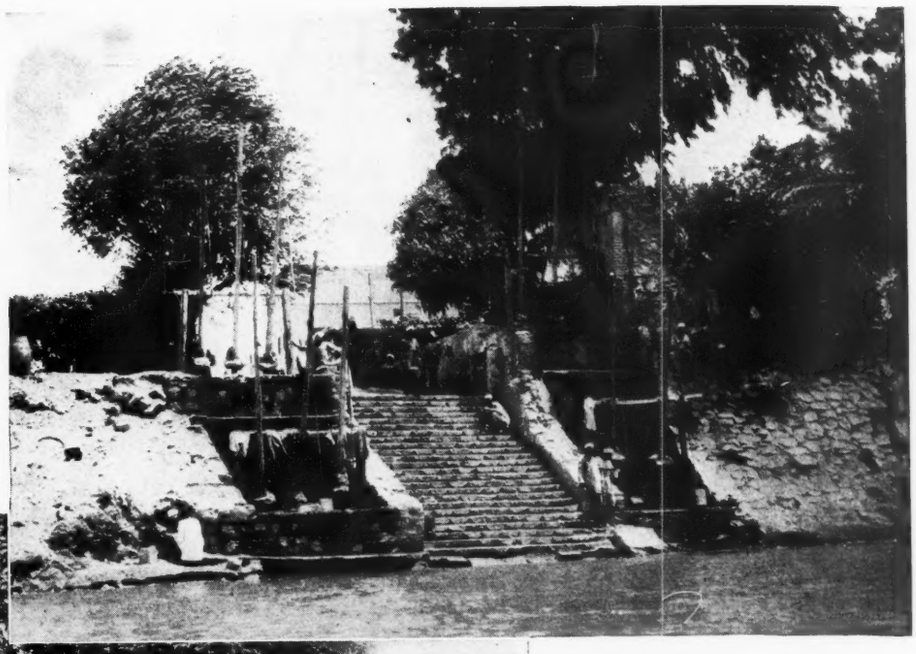


Fig. 4 (Above) — A double shadufe raising water from the Nile to the ditch above

Fig. 5 (Left) — This cow pump is in operation at Trichnopoly, India

Fig. 6 (Below) — Chinese boys running a tread mill to raise water

PILOT-VALVE CONTROL

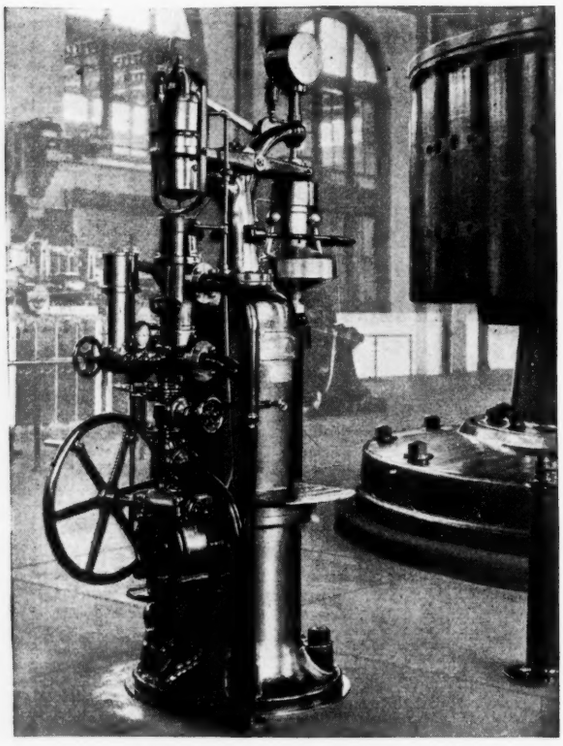
Applied to

Water-wheel Governor

FOR TESTING OPERATIONS

By E. B. Strowger

Assistant Hydraulic Engineer,
The Niagara Falls Power Company



Type of governor on which the control device was applied

REFERENCE was made, by the writer, in the Dec. 20, 1927, issue, page 969, to a special hand-control device applied to a waterwheel governor, in connection with a brief description of a Gibson test. The test referred to was made on a turbine whose existing governor was not adapted or designed to give the desired performance for the testing operations. Several requests for more detailed information regarding this simple device and its application seemed to warrant a short description of it.

The Gibson method of testing hydro-electric power plants requires a means of gradually stopping the flow in the penstock to produce the pressure-time diagram recorded by the Gibson apparatus. This is accomplished by closing the turbine gates by means of the governor.

To illustrate a typical pressure-time diagram, the reader is referred to Fig. 1-*A*. The diagram in this figure is not delineated, but has marked thereon the points of beginning and ending of the diagram. At *A* the turbine gates started to close, and at *D* the closure was complete. For a technical description of the method the reader is referred to *Trans. A.S.M.E.*, Vol. 45, page 343.

There are means provided on the modern governor for closing the turbine gates. In general that method should be used, in connection with the making of pressure-time diagrams, which closes the gates most uniformly with respect to time. Fig. 1-*B* gives the relation between gate motion and time for the diagram shown in Fig. 1-*A*. Fig. 1-*B* is a gate-opening time chart taken directly from the regulating piston rod and gives the motion of the piston related to time. Fig. 1-*C* gives the relation between guide-vane opening and piston stroke and the resulting diagram, Fig. 1-*D*, gives the relation between guide-vane opening and time for the closure in question.

Guide-vane opening rather than piston stroke is a measure of the orifice opening of the turbine. From *A* to *B* the inertia of the moving parts causes a relatively slow motion, and from *C* to *D* the cushioning of the regulating cylinders, and in this case the character of operating gear, slows up the motion. The straight portion *BC* shows an approximately uniform motion with respect to time. The time *T'* is the actual total time of closure and *T* is the nominal closure used in certain studies concerning water hammer and speed-rise problems when for simplicity the entire stroke is to be taken as uniform.

With a given governor installation, the total time *T'* depends upon the total time of operating the closing device, and the shape of the curve depends upon the rate of motion of the closing device. If the closure were made with a uniform motion of guide vane for the entire stroke, then the straight line from *A* to *D* would represent the motion. The pressure-time diagram in Fig. 1-*A* was produced when 33,824 kw. was thrown off a 70,000-hp. unit in 19.2 sec. This diagram gave 1,998 sec.-ft. as the flow in the penstock immediately before the closure.

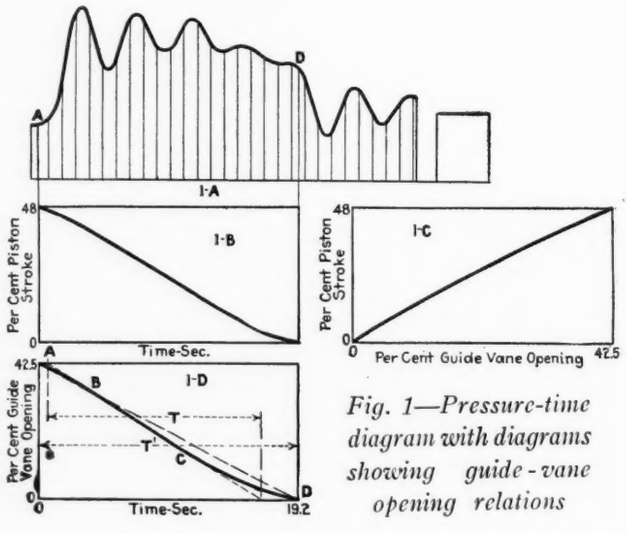


Fig. 1—Pressure-time diagram with diagrams showing guide-vane opening relations

The usual means for closing the turbine gates, available on the modern governor, are:

1. Hand control.
2. Governor control with lever attached to pilot-valve stem.
3. Speed-regulating handwheel.
4. Load-limit device.
5. Special pilot-valve control device.

The writer has frequently found that the hand control, as furnished, operates too slowly for obtaining diagrams, so that one of the other means of closure is generally used. The improvised method of attaching a lever to the pilot-valve stem and lifting or lowering the pilot valve, as the case may require, against the action of the flyballs and dashpot, has been used successfully, but success depends to some extent on the personal equation of the governor operator.

The speed-regulating handwheel is invariably installed on a hydraulic governor and may be used in most cases of closure. Designed correctly with the qualities of smooth operation and negligible lost motion, the operator may control the gate motion as desired by this means.

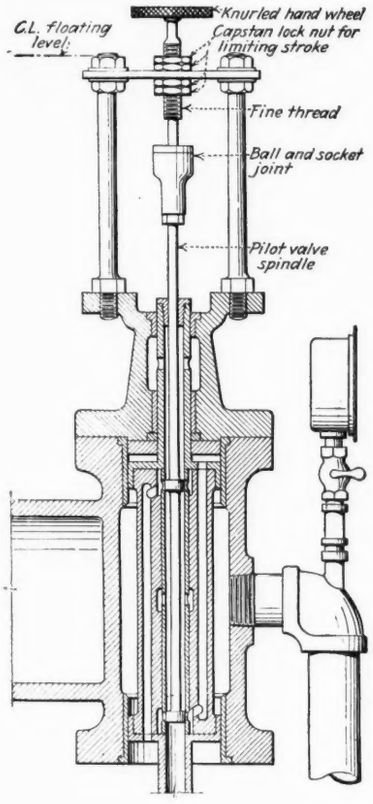


Fig. 2 (Left)—Special pilot-valve control device, which is applied by first disconnecting the pilot-valve stem from the floating lever and then the yoke and adjusting screw are attached as shown

Fig. 3 (Right)—Partial cross-section of the governor showing the pilot valve disconnected and the special control device mounted below the dashpot

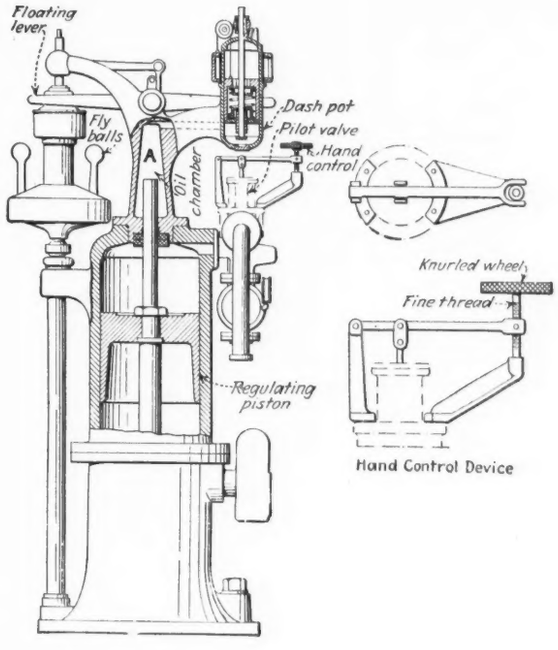
The load-limiting device, when available, may almost always be used for the closures, since with this means the position of the pilot valve is independent of the action of the flyballs or of the dashpot while closing, but depends only upon the progressive setting (or motion) of the limiting device.

The special pilot-valve control device mentioned in item 5 is merely a special hand control applied to the pilot valve. This simple device has frequently been used in testing operations not only for better controlling the closing characteristics of the governor, but in holding a certain load constant immediately prior to the closure. The application is illustrated in Fig. 2, where it can be seen that the pilot-valve stem of the governor is first disconnected from the floating lever and then the yoke and adjusting screw attached, as shown. The thread on the screw should be fine, say 24 threads per inch, in order to control closely the pilot valve, with its relatively short movement.

When a hydro-electric unit is isolated from the system or has very little connected Wr^2, flywheel effect, then the attachment just described is valuable in maintaining a constant gate setting for the short interval prior to a test run as well as producing the desired gate motion. With the floating lever disconnected, the flyballs have no influence upon the regulation of the gates and tests may be run at constant gate settings.

With a large amount of flywheel effect connected to the operating unit under test, one or several of the means of closing already mentioned in items 2, 3 and 4 are usually available to the operator. However, in the special case mentioned in the previous article already referred to, regarding the testing of the Niagara plant (now Adams Station) units of The Niagara Falls Power Company, the governor design was not conducive to steady operation, but on the contrary the turbine gates at fractional openings had a tendency to creep. A partial cross-section of the governor is shown in Fig. 3.

Due to the dashpot design, which embodied a dashpot oil chamber *A* into which the stem from the main operating cylinder projected, a tendency for a gradual creeping of the gates from one position to another was augmented, an interchange of load taking place between two or more units during the process. With a creeping of the regulating cylinder in one direction, the displacement of the oil in the oil chamber caused the creeping to persist by its action on the dashpot. The trouble was not correctly diagnosed until recently, but it was known that the attachment, as shown mounted on the governor in Fig. 3, cured the trouble. This figure shows a partial cross-section of the governor referred to, with the pilot valve disconnected from the floating lever and the device mounted below the dashpot. The headpiece presents a view of the governor with the device removed and the pilot valve reconnected to the floating lever as required for normal operation of the waterwheel.



Modern Control Valves *for Evaporating Systems*

By George Hilger

EVAPORATING units in refrigerating plants may be classed as to arrangement of surface, kind of cooling work to be done and method of operation. With respect to arrangement of surface, there are the following kinds: Pipe coils, shell and coils, shell and tube, double or triple pipe, or combinations of these types. With respect to kind of cooling work to be done, it is evident that the particular type of duty will require an evaporator of a given type. In some cases the evaporators are operated on the dry expansion method, and in other cases they are operated on the flooded principle. In the dry expansion method the evaporators are fed so that the vapor at the outlet may be superheated a few degrees. In the flooded system, as the name indicates, the evaporator surfaces are more or less flooded, which reduces the superheat in the vapor at the evaporator outlet.

*Abstract of paper presented before the Spring Meeting of the American Society of Refrigerating Engineers, Detroit, Mich., June 5, 1928.

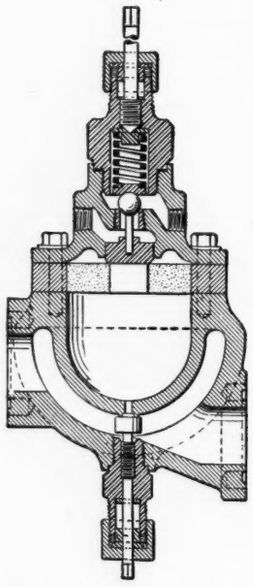


Fig. 1—No-freeze-back control valve

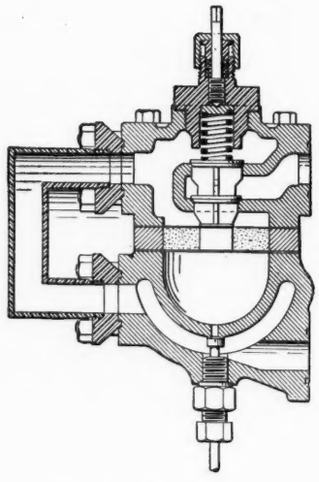


Fig. 2—Flash-gas contol valve

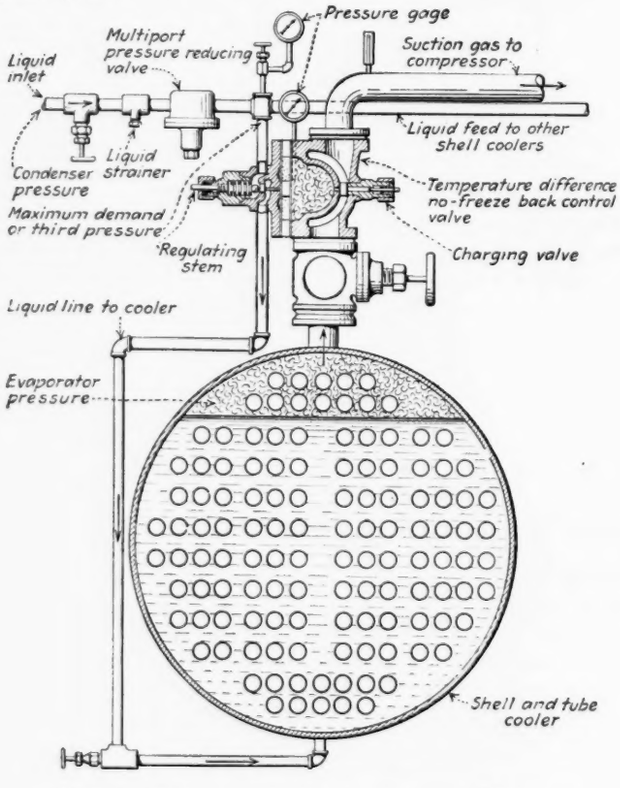


Fig. 3—Three-pressure temperature-difference control system

The original method of controlling the admission of the liquid to the evaporator consisted of the hand-operated pressure throttling valve, commonly called the "expansion" valve. The results obtained with the hand-operated valve depend to a large extent upon the judgment of the operator.

The next step in the improvement of control systems was the development of automatic pressure-reducing valves, which are sometimes called "automatic" expansion valves. Even with these valves the relative perfection of operation depends to a considerable extent upon the design of the valve, as well as upon the materials of construction.

One design of automatic pressure-reducing valve which has given good results under operating conditions, is of the multi-port diaphragm type. The pressure in the evaporator is balanced by means of compression springs. The valve has four special stems and seats. Positive closing action is obtained by individual compression springs which exert pressure upon the four valve stems. When the valve is set to feed refrigerant at a given evaporating pressure, a small reduction of evaporator pressure allows the valve to open slightly. A small increase in pressure tends to allow the springs to close the valve, thus obtaining regulation of refrigerant flow in evaporator. Consequently, this type of valve is sensitive to pressure only. It is not sensitive to the temperature or amount of liquid in the evaporator.

The next important step in the development of control devices for evaporators was the design and perfection of a control valve that would be sensitive to the temperature of the refrigerant at the evaporator outlet. An attempt was made to design a valve that would control the condition of the vapor at the evaporator outlet, thereby automatically controlling the condition of the refrigerant in the evaporator as a whole. After a series

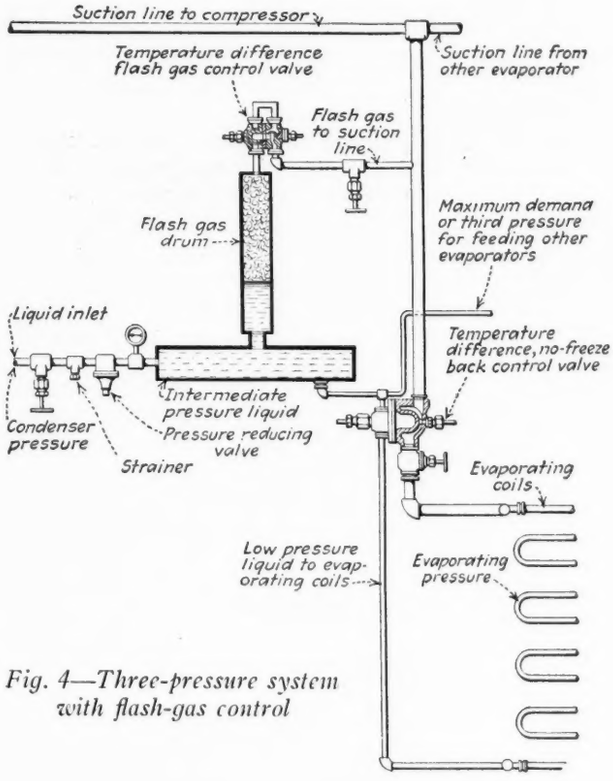


Fig. 4—Three-pressure system with flash-gas control

of exhaustive experiments a valve of the design and construction shown in Fig. 1 was developed. This valve consists essentially of a thermal chamber, so designed that it may be placed directly in the flow of gas in the suction line from the evaporator, a pair of insulated diaphragms, a pusher rod, a valve and seat, together with a compression spring and an adjusting stem. The thermal chamber is charged with the vapor and some liquid of the refrigerant. The liquid is admitted to the valve in the space above the ball valve, passes through the ball valve into the space underneath the same, and from here it flows to the evaporator. The suction from the evaporator is connected to the lower left port, and the lower right port is connected to the compressor suction line.

By the simple adjustment of the pressure exerted by the compression spring upon the ball valve, the amount of liquid refrigerant admitted to the evaporator is controlled positively by a few degrees of superheat in suction gas as it passes around the thermal chamber. Some of the heat due to the temperature of the suction gas is transmitted to the saturated refrigerant in the thermal chamber. This causes the pressure to rise in the thermal chamber until the saturated pressure due to the temperature of the suction gas is reached. The pressure is transmitted through the diaphragms to the ball valve, and it is opposed by the evaporator pressure, the compression spring pressure and the differential pressure of the refrigerant above and below the ball valve. These forces are balanced just as a body is weighed on a beam scale. A slight increase of superheat in the suction gas at the valve tends to feed more refrigerant into the evaporator; a slight decrease in superheat tends to reduce the amount of refrigerant fed to the evaporator. Consequently, it will be observed that the admission of refrigerant to the evaporator is actually and positively controlled by the superheat in the suction as it passes through the valve. The valve is therefore sensitive to the temperature of the suction gas and is direct acting, since it is mounted in the suction line at the evaporator outlet. The valve is called a "temperature-difference no-freeze back" control valve.

After the temperature-difference control valve was perfected, a critical study of all the factors entering into the control and regulation of evaporators revealed that there was a need for some process that would increase the sensitiveness of the control devices and that would meet the demands of all kinds of operating conditions.

After considerable experimentation the three-pressure refrigerating system was developed. In this system there are three operating pressures—the condenser pressure, the normal suction pressure and the maximum-demand pressure. This third pressure is set by means of a pressure-reducing valve. The liquid refrigerant under the third pressure is fed to temperature-difference con-

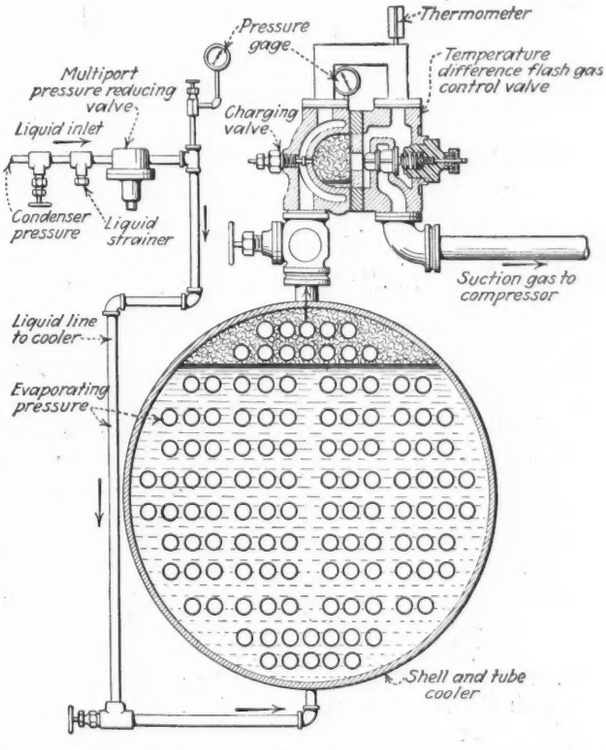


Fig. 5—Three-pressure flash-gas control system for a constant evaporator pressure

trol valves, which in turn feed the evaporators. The third pressure is so set that the refrigerant temperature will be about 5 deg. F. below the coldest temperature of the material cooled by any evaporators. In most cases the third pressure will be 5 to 10 lb. above the normal evaporating pressure. By using an automatic pressure-reducing valve to establish a maximum demand or supply pressure, the corresponding temperature of which is 5 deg. below the temperature of the material cooled

by any evaporator, it is obvious that the temperature difference-control valve will close when the temperature of the material to be cooled reaches a point above the evaporating temperature equal to the degrees of superheat for which the valve is set. This action not only prevents such an evaporator from becoming a condenser, under variable load conditions, but also allows it to function properly when refrigeration is again increased.

The use of the three-pressure system makes it possible to shunt the flash gas around the evaporator, thus allowing practically all liquid to be admitted to the evaporator.

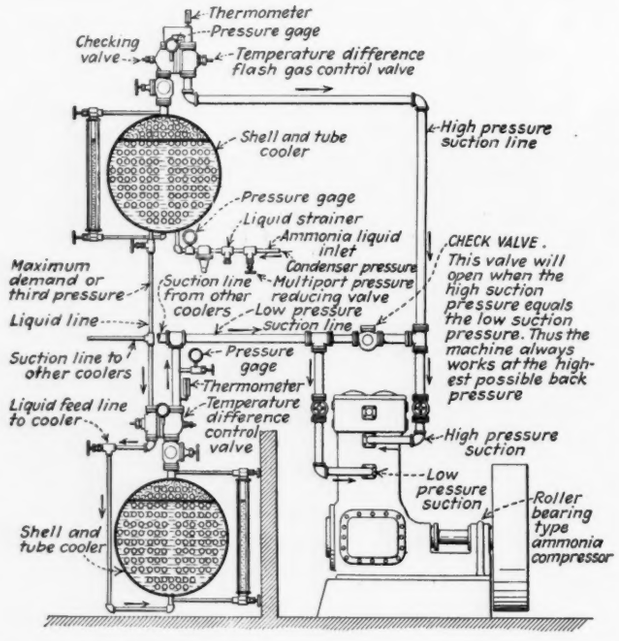

Thermometer
Pressure gage
Checking valve
Temperature difference flash gas control valve
High pressure suction line
Shell and tube cooler
Pressure gage
Liquid strainer
Ammonia liquid inlet
CHECK VALVE. This valve will open when the high suction pressure equals the low suction pressure. Thus the machine always works at the highest possible back pressure
Condenser pressure
Maximum demand or third pressure
Suction line from other coolers
Multiport pressure reducing valve
Low pressure suction line
Liquid line
Suction line to other coolers
Pressure gage
Thermometer
Liquid feed line to cooler
Temperature difference control valve
High pressure suction
Low pressure suction
Roller bearing type ammonia compressor
Shell and tube cooler

Fig. 6—The three-pressure system arranged for constant and variable pressure evaporators

The system further makes it a convenient procedure to defrost any of the evaporators that may become coated with ice and frost.

The adaptation of the foregoing principles to the control of a shell-and-tube cooler is shown in Fig. 3. The cooler is controlled by the three-pressure system in combination with a temperature-difference control valve. The liquid refrigerant under condenser pressure is led into a multi-port pressure-reducing valve that is set so as to maintain a maximum demand, or third pressure. The liquid under the third pressure is led to the temperature-difference control valve, which controls the flow or liquid into the cooler, at the evaporating pressure of the cooler, in accordance with the adjustment of the valve. As the superheat of gas at the cooler outlet will vary with the liquid level, it is evident that the valve may be set so that it will regulate the flow of liquid refrigerant to the cooler according to the requirements. The liquid refrigerant under the third, or maximum-demand, pressure may be led to other coolers and their operation controlled in a similar manner.

The temperature-difference control valve is shown in section. The thermal chamber is placed directly in the flow of gas from the cooler. It is, therefore, responsive to any change of condition that may occur in the cooler. Gages are placed on the third pressure line and on the thermal chamber.

When the three-pressure system had been perfected, it became apparent that means should be provided for shunting the flash gas around the evaporator. This was made possible by the adaptation of the temperature-difference valve principle in the form as shown by Fig. 2. This valve has a suction-gas inlet around the thermal chamber, a bypass connection to the upper part of the valve and a double-seated valve. The superheat in the suction gas returning to the valve provides the motive power for operation. The heat from the suction reacts upon the refrigerant in the thermal chamber, causing a higher pressure in the chamber. The force due to this pressure is transmitted through the double-insulated diaphragms to the valve. This action is opposed by the force due to the compression spring. Increasing the superheat in the suction gas tends to open the valve; decreasing the superheat tends to close it.

Regulation of the relative superheat in the suction gas is obtained by adjusting the compresssion spring on the valve. By increasing the compression of the spring, more superheat is required to open the valve; by decreasing the compression of the spring, less superheat is required to open the valve. The valve is called a "temperature-difference flash-gas" control valve.

The use of the valve for shunting the flash gas around the evaporator is illustrated by Fig. 4.

Here the three-pressure system is operated with a temperature-difference no-freeze-back control valve on some evaporating coils. The three-pressure system and valve operate as previously described. When the liquid refrigerant is reduced from the condenser to the third, or intermediate, pressure, part of the liquid is evaporated to cool the remainder to the corresponding temperature. This flash gas is trapped in a flash-gas drum, where it accumulates, and by the action of the flash-gas control valve it is automatically discharged to the main suction line. When the liquid level falls in the flash-gas drum, owing to the accumulation of flash gas, the relative superheat in the gas at the valve is increased. This causes the valve to open, thus expanding flash gas from the third pressure down to the suction pressure in the main suction line. When the liquid level rises, owing to the escape of the flash gas, the relative superheat in the gas at the valve is diminished, thereby causing the valve to close. In actual operation the valve and drum come to a balanced condition, whereby the flash gas is continually removed from the flash-gas drum. When the flash gas is thus removed, practically solid liquid is fed by the temperature-difference control valve to the evaporating coils.

In the three-pressure refrigerating systems the third pressure is maintained constant, by means of an automatic pressure-reducing valve. As previously shown, it is a simple matter to remove the flash gas. The same principles may be used to govern the operation of constant-pressure evaporators. In this case the pressure-reducing valve is set for the desired evaporator pressure. A temperature-difference flash-gas valve is attached to the evaporator outlet for the purpose of controlling the amount of refrigerant admitted to the evaporator. The arrangement of the apparatus is shown in Fig. 5.

The high-pressure liquid is led into an automatic pressure-reducing valve. The liquid then flows from the pressure-reducing valve, under evaporator pressure, into the evaporator. The height of liquid in the evaporator, and hence the degrees of superheat at the temperature-difference flash-gas valve, is readily maintained at any point by means of the proper adjustment of the compression of the spring in the valve. Should the liquid level tend to fall, the increased superheat in the

gas causes the flash-gas valve to be held open; should the liquid level tend to rise, the decreased superheat in the gas at the valve tends to close it. Thus the pressure may be maintained at constant value and the liquid controlled by means of the combination of the pressure-reducing valve and the flash-gas valve. It should be noted that the evaporator pressure will be maintained constant at the set point regardless of the fact that the suction pressure to the compressor may be equal to or below the evaporating pressure in the cooler.

The constant-pressure evaporator is especially adaptable to water-cooling installations, since, by means of the pressure control, all possibilities of freezing up the coolers are eliminated.

The three-pressure refrigerating system is applicable to all kinds of evaporators that have either constant or variable evaporating pressures. While it is necessary to study all the local conditions in a given case, the general principle underlying the actions of the various component parts of the system is the same in all cases, which makes it possible to provide an evaporator control system which operates at the highest efficiency. This improves the operating efficiency of the refrigerating system as a whole.

The adaptation of those control principles to a refrigerating system that has a constant-pressure high-temperature evaporator and a more or less variable low-pressure low-temperature evaporator is further illustrated in Fig. 6. The high-temperature evaporator is shown as a shell-and-tube cooler, the operation of which is controlled by means of the automatic pressure-reducing valve and the flash-gas control valve. The gas formed in the cooler due to the external refrigerating work, as well as that due to the cooling of the liquid refrigerant from the temperature on the high-pressure side to the temperature in the evaporator, is withdrawn from the cooler through the flash-gas valve to the high-pressure port on the compressor. The subcooled liquid refrigerant from this cooler is led to the temperature-difference control valves on the low-pressure evaporators, which control and regulate the refrigerant in such evaporators. The low-pressure gas from the low-temperature evaporators is led to the low-pressure port of the compressor.

In the event that it is desired to cool water in the high-pressure evaporator, the evaporating pressure may be so set and maintained that the possibilities of freezing up the cooler are entirely eliminated. It is obvious that the three-pressure system is especially applicable to the forecooling of water and the control of the brine-cooling evaporators in an ice plant.

Diesel Operating Costs of Los Angeles Water Works

IT IS extremely difficult to obtain accurate operating costs of either steam or oil engine plants. In the case of the Los Angeles, California, Water Works Department, which operates three Diesel pumping stations, the costs are accurately kept and those of the Lankershim plant are given in the table.

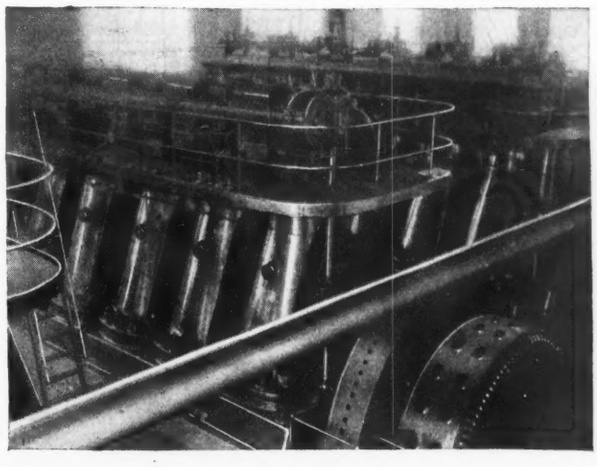
As is well known, the principal water supply for Los Angeles is obtained from the Owens Valley, an aqueduct bringing the water to the city. In certain parts of the city, however, the water is obtained from wells.

Three Diesel plants supply the electrical energy used to operate the deepwell pumps and in addition during the off-peak periods also return to the municipal electric distribution system the energy drawn from these lines by the water department at other periods.

In the Lankershim station there are three 1,150-hp. Fulton Diesels, two of which are illustrated.

The tabulation of the Lankershim costs includes data on the results obtained between July 1 and Oct. 1, 1926, and between July 1, 1926, and Jan. 30, 1927.

The figures for all items of expense except fuel oil and lubricating oil have been taken from the reports furnished by the Water Cost Division, but no indirect or fixed charges are included. As it was desired to select a period of heavy load, it was necessary to use the figures for the four heavy months of 1926, as no monthly cost



Diesel engines in the Lankershim plant

reports for any of the pumping plants had been received from the Water Cost Division covering the five months prior to October, 1927.

When the figures for the heavy-load period are compared to the corresponding figures for the year, it is obvious that it would be greatly to the advantage of the department if arrangements could be made with the Bureau of Power and Light which would permit the operation of this plant at as nearly full load as possible instead of limiting it to a load not to exceed the power demand of the various other pumping plants, which falls as low as 500 kw. during the winter months, as is done under the present arrangement.

Under the present arrangement a charge for line rental of two mills per kilowatt-hour is added to the cost of production indicated, and in addition to this a deduction of approximately 14.2 per cent for transformation and transmission losses is to be taken into account in arriving at the cost of the power delivered at the point of consumption.

OPERATING COSTS, LANKERSHIM DIESEL PLANT

	July 1 to Oct. 30, 1926, Inc.		July 1, 1926, to June 30, 1927	
	Total Cost	Cost per Kw.-Hr.	Total Cost	Cost per Kw.-Hr.
Operating labor	*5,170.37	$0.000795	$15,844.28	$0.001150
Fuel	17,487.16	.002683	36,196.40	.002623
Lubricants	2,567.31	.000395	5,686.84	.000413
Miscellaneous materials	116.79	.000017	743.62	.000054
Labor and materials for repairs	1,835.55	.000282	10,337.83	.000753
Total cost	$27,177.18	$0.004172	$68,808.97	$0.004993
Kw.-hr. generated	6,512,380		13,797,070	
Average load, kw.	2,225		1,573	
Total cost per kw.-hr.		$0.00417		$0.00499

Reclaiming Superheater Units by Welding

By James M. Vossler*

AS SUPERHEATER units get old, the bends closest to the fire are the first parts to develop trouble. In such a case the practice has been to cut off the bends and apply new ones having threaded joints. It was realized that if some form of autogenously welded bend could be applied directly to the unit, a more durable and economical repair could be effected.

Fig. 1—End of unit ready for closing. Fig. 2—Tubes heated and bent together. Fig. 3—Completed bend cut open

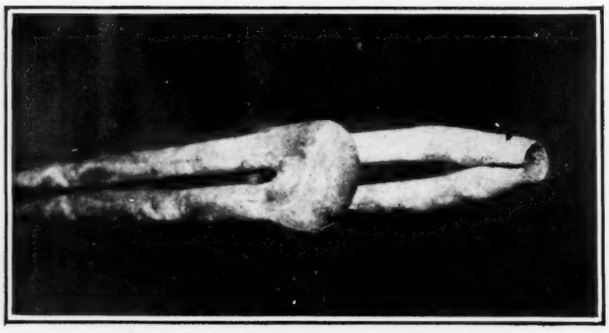


Fig. 4—Bend prepared for welding
Note the round hole at end that must be filled.

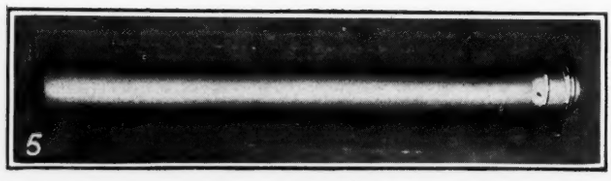
The first attempts to make welded bends on the ends of the superheater tubes were not successful, but after many trials the autogenously welded bend here described was developed. In making the welded bend, the first operation is to cut off the old bend with a cutting torch and to shape the superheater unit as shown in Fig. 1. The tubes are then heated just back of the bevel and are bent together as shown in Fig. 2. The cut ends of the unit tubing are heavily rapped with a hammer to loosen all scale that may be therein. The two tubes are then placed in position and tack welded to keep them in alignment.

The next operation is to weld the lengthwise seam. Considerable care should be taken with this weld. The unit tubing is too thin to justify beveling and care must be exercised to see that the fusion extends entirely through the seam. After the welding of the lengthwise seam has been completed, the round hole left open at the end, about $\frac{7}{8}$ in. in diameter, must not only be plugged, but must be built up heavily in order to reinforce the joint.

A unit end completed is shown in Fig. 3. It has been sawed and hinged in a door-like manner so that the inside can be seen. It will be noted that the cross-section at the point of union of the two tubes in the welded bend is very liberal, being considerably greater than the cross-section of the tubes. The time required to complete the bend will average about 45 min., including the preparation work. The autogenously welded unit bend is far superior to the screwed-joint bend and has proved itself at least equal to any other form of superheater bend. In Fig. 4 is shown a bend prepared and ready to be welded.

The objection may be raised that the efficiency of the unit is lowered, in that its heating surface is decreased when the old bend is cut away and the new bend is constructed as already described. This, of course, is to some extent true, but the decrease is very slight and it is a simple calculation to prove that the loss in efficiency is not worthy of consideration. It can be further seen that the longer the unit, the smaller is the percentage of surface that is lost.

Another part of the superheater unit that is found to wear out before the rest is the neck. Often the neck is found to be thin on the fire side of the upper portion of the curve. When the condition of the rest of the unit is good enough to justify the replacement of the neck section, a new neck can be prepared by forging the ball joint on a piece of proper size tubing in a forging machine. After the forging operation the neck is bent into proper shape and is welded onto the unit. Fig. 5 shows the new neck after the ball joint and collar have been forged, while Fig. 6 shows the new neck properly bent and welded in position on the unit.—*American Machinist.*



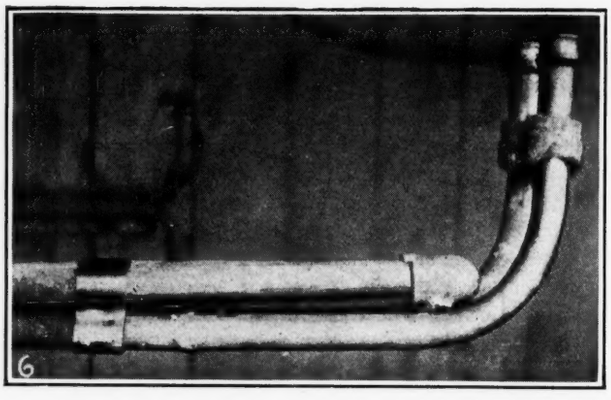


Fig. 5—Ball joint forged on neck. Fig. 6—Neck bent and welded to unit

**Welding Instructor, Southern Pacific Lines, Texas and Louisiana.*

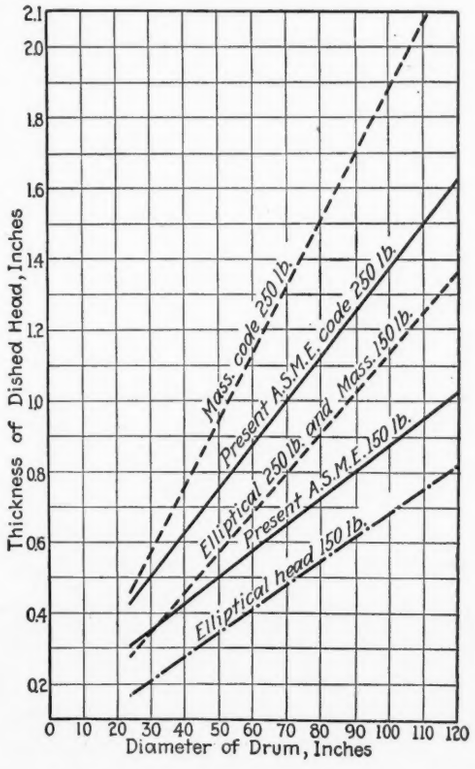
A Different Boiler and Setting

IN THE pulverized coal report of the International Railway Fuel Association, the first part of which was reproduced in *Power* for June 5, a cross-section appears of one of the boilers at the Missabe & Northern Railroad's Proctor plant. This illustration was taken from a preliminary drawing. The installation as finally decided upon and put in contains a Casey-Hedges boiler with a somewhat different setting altered to accommodate this type of boiler.

New Rules for Dished Heads

IN THE July 17 issue of *Power* were published a number of new and revised rules for dished heads as proposed by the Boiler Code Committee. The two most significant changes to these rules are the recommended use of the Massachusetts Code formula for calculating the thickness of blank unstayed dished heads with the dash-and-dot curve and are at least as thick as the thickness that is required of a seamless shell of the same diameter. For heads with manholes the new rules require an additional thickness of 15 per cent, but in no case less than $\frac{1}{8}$ inch.

It will be noted that the Massachusetts formula for low pressures and small sizes gives a lighter head than the present A.S.M.E. formula, while at high pressures and larger sizes the Massachusetts formula requires a greater thickness. The elliptical head type of construction allows a lighter plate to be used than either of the other methods. This is forcibly brought out by the curves which indicate that an elliptical head for 250 lb. pressure may be of the same thickness as a dished head that is designed by the Massachusetts code for 150-lb. pressure.



Methods of calculating thickness of dished heads compared

pressure on the concave side, and the rule regarding the thickness of blank heads of semi-elliptical form.

In order to show more clearly the effect of these changes in the construction of boiler drums, the thicknesses of dished heads for various drum diameters and for two different pressures were calculated according to the new proposed formulas and the old A.S.M.E. equation. The accompanying curves show the results of these calculations.

The thicknesses indicated by the solid line have been calculated by the A.S.M.E. equation, which is as follows:

$$t = \frac{5.5 \times P \times L}{2 \times TS} + \frac{1}{8}$$

Those indicated by the dotted line have been calculated from the Massachusetts Code formula, which is

$$t = \frac{8.33 \times P \times L}{2 \times TS}$$

where

t = thickness of plate, in.;
P = maximum allowable working pressure:
TS = tensile strength, lb. per sq.in.;
L = radius to which the head is dished, measured on the concave side, inches.

The thickness required in a blank head of a semi-elliptical form in which the minor axis of the ellipse is at least one-half the diameter of the shell, are indicated by the

Imagine the Savings!

By J. W. Sauerbrei

VARIOUS editorials have been written dealing with the opportunities there would be for savings in the factory if the same care were exercised as in the power house.

Opportunities to save are not confined solely to the factory, as the illustrations will show, and it is the engineer's job to stop these leaks.

Fig. 1 (Above)—A view of the pipe lines

Fig. 2 (Below)—A close-up of the leaky staves

The illustrations are of two power-house conduits in Canada. The wood pipe lines leak at a thousand joints, and the water loss is high. In addition the water tends to weaken the pipe-line supports.

The moral is obvious. The engineer should get out with a wrench and tighten up the bands. That he does not is difficult to explain.

You Can Reduce Repair Costs and Improve Electrical-Equipment Service If You

Make Insulation Resistance Tests

By H. E. Stafford

Electrical Engineer, Provincial Paper Co., Ltd., Port Arthur, Ontario

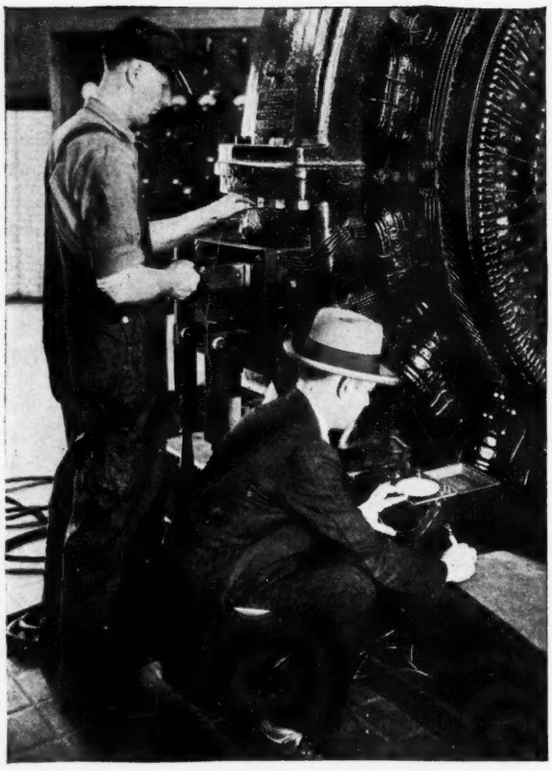


Fig. 1—Making an insulation test on a large direct-current generator

PRACTICALLY all breakdowns of electrical equipment are directly due to low insulation resistance. Cracks in the insulation allow moisture to enter to the conductor and form a path to another conductor whose insulation is similarly affected. Water, however, is not the only reason for electrical equipment failures, as metallic and carbon dusts also cause many breakdowns. If these defects are found and repaired before they develop into a failure, the cost of making the repair will be materially reduced and the machine can be taken out of service at a time when it will cause the least interruption to production.

For testing insulation resistance there are several instruments on the market which give a direct reading and are the best for this purpose. In testing the insulation resistance of a group of feeders, each feeder should be isolated and tested separately. Assuming a feeder is found that gives a low-resistance reading, the feeder circuit is split up into as many units as possible and each unit tested until that showing the lowest reading is located.

It must be understood that different types of equipment will have different values of insulation resistance; for instance, the wiring will usually show a higher value of resistance than the apparatus to which it connects. There is no hard and fast rule for determining what value of insulation resistance is best, although the American Institute of Electrical Engineers has adopted a standard that should be followed as closely as possible. This rule states that the insulation resistance of a machine at its operating temperature shall not be less than that given by the formula,

$$\textit{Insulation resistance in megohms} = \frac{\textit{voltage at terminals}}{\textit{rating in kva.} + 1{,}000}$$

While this rule is arbitrary, it serves as a guide which should be closely followed in new equipment, but which I have found from experience is not to be relied upon for equipment that has been in service for any great length of time and that has been under the influence of moisture, oil and chemical fumes or metallic dust. My experience has shown that the following values should be used for the various types of equipment:

110-volt motors, a.c. or d.c.	250,000 ohms 0.25 megohm
220-volt motors, a.c. or d.c.	500,000 ohms 0.5 megohm
440- and 550-volt motors, a.c. or d.c.	750,000 ohms 0.75 megohm to 1,000,000 ohms 1.00 megohm
Compensators and controllers, all voltages up to 550 volts	500,000 ohms 0.5 megohm
Power wiring up to 2,200 volts	20 megohms to infinity
Light wiring with all sockets and receptacles connected but without appliances	1,000,000 ohms 1.00 megohm

Records of all insulation resistance tests should be filed for future reference. For instance, if a test today gave a reading of 750,000 ohms, a reading a year from today might show only 500,000 ohms. The difference will show that the insulation is deteriorating and that it is best to take the motor out of service, bake it thoroughly and give it a good coat of insulating varnish, applied hot. If no record had been kept of this motor, an insulation resistance of 500,000 ohms might have been taken as being O.K. and a burn-out of the winding might have occurred.

If the apparatus under test is absolutely dry, a high value of insulation resistance will be recorded even if the insulating is gone in exposed spots. This same apparatus might be subjected to a voltage several times greater than it was designed for and the insulation still stand up; but, if placed where dampness existed or air heavily laden with metallic or carbon dust, it would undoubtedly fail in a short time. The insulation resistance to ground in a case of this kind is no indication of the condition of the apparatus, neither is it an indication of what value of voltage might be applied. The exposed parts of a machine should therefore be rigidly inspected when an insulation test is being made.

Electrical Applications

Equipment subject to high voltages should be tested with normal voltage plus 1,000 volts, in addition to making an insulation-resistance test. A 1,000-kva. motor operating at 2,200 volts should show a test of 1.1 megohms according to the A.I.E.E. rules, but if this motor happens to be second hand and I was the purchaser, nothing less than a 10-megohm test would be considered.

In making tests, the beginner should bear in mind that insulation has a higher resistance when cold than when hot, and therefore a machine that shows 10 megohms cold

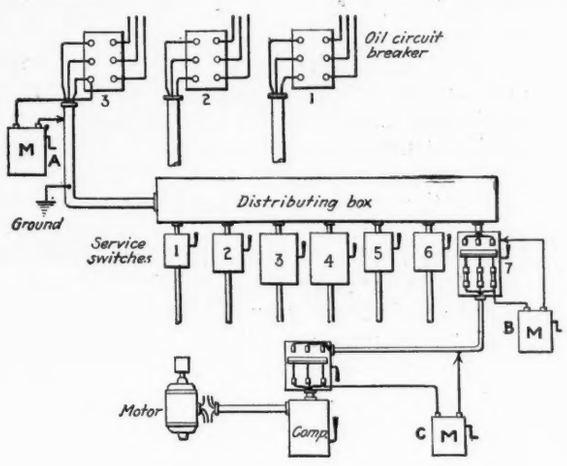


Fig. 2—Shows how the wiring to a motor is sectionalized to locate low insulation resistance

The instrument for obtaining a direct reading of the insulation resistance is shown connected at *M*. One instrument is used to take the readings at *A*, *B* and *C*, respectively.

might have only 9 when hot. If a machine is heavily loaded and gives a cold test just within the limit, when operating it will be below the limits of safety.

Considering the question of interpreting the tests of a system of feeders, assume that the system is equipped with ground detectors and that the detectors indicate a slight ground at certain intervals. A fault of this type is called a swinging ground and might be caused from a conductor coming in contact with the ground by the action of the wind, by the internal stresses of a motor causing the insulation to chafe in the slots, or by vibration.

A trouble of this kind is sometimes mystifying, and unless a reliable instrument is used it is hard to locate until such time as the insulation breaks down. The first thing to do in a case of this kind is to isolate each feeder in turn and test the resistance of each. After the offending circuit is located, the next step is to split it up into various sections, as shown in Fig. 2. Assume the circuit gives a resistance test of 80,000 ohms when the insulation test is made as at *A*. The next operation is to open each service switch from 1 to 7, testing after each is opened. If, after all the switches have been opened except No. 7, the low reading persists, it might be assumed that the trouble is in No. 7. Such might not be the case, and No. 7 should also be opened. If the insulation reading at *A* is still the same, the trouble is in the wiring between the circuit breaker and the distribution box. If, however, the resistance reading goes up, the trouble is in sub-circuit No. 7.

Next open the switch ahead of the compensator and test at *B*. If the reading is high, open the leads at the motor and test at *C*. If this test also shows a high resistance, the trouble is in the motor. Next, open up the star connection if the motor is star-connected, as shown in Fig. 4, and test each phase winding. If the motor is delta-connected, open the connections between phases as shown in Fig. 5. When the ground is in a phase winding, in either connection, open the connection between the various pole groups of this phase and test each group. After the offending group is located, open the connections between the coils and test until the grounded coil is located. When this test is started, oil switch 3 is open and the service switches and compensators are closed. This ties all the equipment together, and by dropping off one section at a time the offending one is easily located.

If the ground is located in the wiring that is run in conduit, the only remedy is to pull out the existing wires and install new conductors. Never pull a splice in a conduit. It is best to test each of the switches, as these sometimes go to ground by means of high-resistance paths through the fiber or slate bases, due to metallic veins or moisture.

If the ground is located in the compensator, each part is then tested separately. The operating and stationary bars holding the contacts are constructed of wood or of steel with a fiber covering, and it is on these bars or in the coils that the grounds generally occur. A ground on the operating bar is usually hard to locate, as it makes its appearance as a burned crevice in the wood or fiber, the path being formed by minute particles of carbon

Fig. 3—Making an insulation resistance test on lead-covered cables used to connect a large synchronous motor to the line

created by the heat caused by the passage of current through moisture in the oil.

If the circuit feeds a direct-current motor, the same procedure is followed as with an alternating-current motor, only in this case there are a greater number of places where a ground might occur. First of all the controller

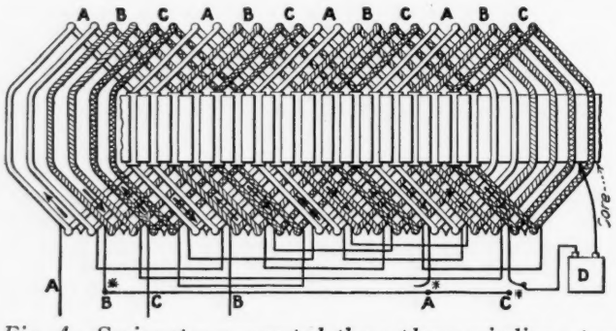


Fig. 4—Series-star connected three-phase winding open at the star connection so that the insulation of each phase may be tested

The instrument *D* for obtaining a direct reading of the insulation resistance is shown connected between phase *C* and the core. Tests are made on the other phases in the same way as for *C*, by connecting one of their leads to the instrument.

is tested, and as it has both field and armature circuits leading from it, each must be isolated from the other. After the controller is tested and the insulation resistance found normal, the armature and field circuits of the motor are tested. There might be three separate field circuits on the machine, each of these being tested separately. Since the series and interpole fields are both in series with the armature, any trouble in the armature circuit will show up in these field circuits unless isolated. If the trouble is finally located in the armature circuit, the brushes are lifted from the commutator and the armature again tested. If the armature is clear, each

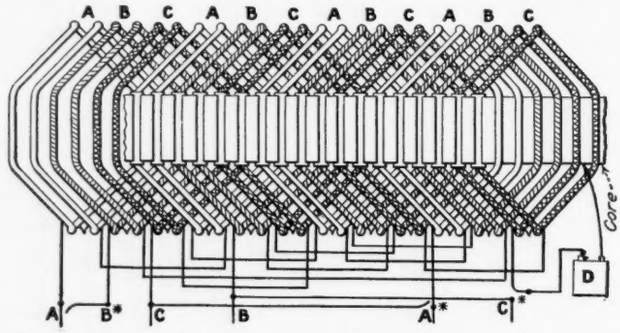


Fig. 5—Series-delta connected three-phase winding open at delta connections for testing the individual phase windings

brush-holder must be tested separately and the one causing the trouble located.

The same procedure is followed in case low resistance is indicated between adjacent feeders. It sometimes happens that two grounds occur on different machines and on different phases or lines. In a case of this kind the two lines have a low-resistance path between them, depending on the distance apart and the nature of the ground. If close together, the two lines thus grounded will be short-circuited and both machines will be made inoperative.

How Many Amperes at 550 Volts?

By H. H. Watson
Industrial Control, Engineering Department, General Electric Company

THIS simple question, characteristic of the requests for capacities of industrial control apparatus, is never correctly answered by a single unqualified reply. Industrial control contactors, relays and other circuit-making and breaking devices such as drum switches, push-button stations or limit switches, have two basic functions which determine their rating. They must first be capable of conducting a certain value of current, and second to make or break current which may be less or greater than the first value, which may be a variable depending on different conditions.

The first consideration is one of continuous capacity. The various associations of electrical manufacturers and the fire-insurance underwriters have definite rulings as to permissible temperature used on the various parts of industrial-control apparatus. Immediately, the limitations of heating establish a maximum value of continuous current. This maximum value, however, has to be used with discretion. The ambient temperature of the installation and the nature of the inclosure with respect to ventilation have their bearing on the amount by which the so-called "continuous rating" has to be discounted to obviate the possibility of obtaining excessive temperatures. So much for current-carrying limitations—thus far industrial-control apparatus parallels all other electrical devices.

The other consideration is that of making and interrupting circuits. At the instant two contact tips at a difference of potential first touch, the initial points of contact are obliged to carry a large current in proportion to their cross-section. Should the tips be moving together slowly, it is seen that the heat dissipated in the restricted contact area under light pressure can be sufficient to fuse the metal of the tip at the point of contact and cause a weld. Carrying this situation farther, it can be readily appreciated that the amount of current which contact tips will handle without welding, regardless of their mutual velocities is a limitation again on maximum capacity.

This welding phenomenon is native to all types of devices from the smallest control relay to the tips of 2,000-ampere contactors.

Again, many contactors can carry currents up to certain values beyond which the magnetic effect of the current tends to open the contactor against the finger spring pressure. This reduction in finger pressure means increased contact resistance, localizes heating, and consequently causes welding.

Generally, the maximum duty impressed on the contacts of a control device is that of current interruption. The factors that influence the ability of some particular design to interrupt circuits at various voltages of direct current are the effectiveness of different forms of arc barriers, arc chutes, blowout constructions, voltage, magnitude of current and frequency of operation—in fact, anything that may be varied.

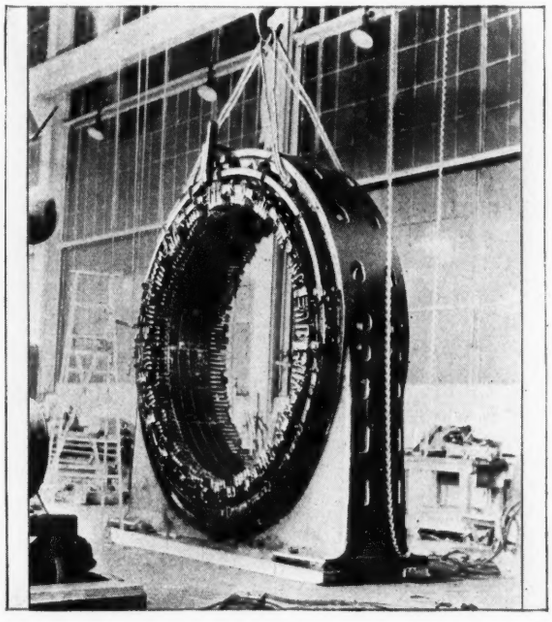
It has been found in alternating-current contactors that speed of opening is probably the most important factor. The shape of the tips, the presence of foreign metallic vapor in the arc, the spacing of the tips, the nature of the inclosure, voltage, frequency, duty cycle—each of these contributes its modification to the interruption ability of the alternating-current device.

Electrical Applications

Motor Generator Repaired in Record Time

THE completion within ten days of an emergency repair job, which under normal conditions would require six weeks, was achieved recently in Detroit. One of the big motor-generator sets used for welding in a large gear and axle plant burned out. The breakdown was serious, as any prolonged delay in getting the set back into service would have seriously affected production. The motor-generator set weighed 54 tons and consisted of a 1,200-hp. induction motor driving a 1,000-kw. 360 r.p.m. two-phase 350-volt generator connected to deliver single-phase current for the axle welder.

The service to which this machine had been subjected, welding 150 axle housings an hour, requiring 150 short-circuits of six seconds each during this time, resulted in



Rewound stator of generator for motor-generator set

almost continuous overload in that the 1,200-hp. motor was obliged to deliver 2,000 hp. for each weld. This overloading loosened the iron in the generator and caused chafing between the coils until finally a short circuit burned out the set.

Examination showed that five coils, consisting of $1\frac{1}{2}$x$\frac{1}{2}$-in. bar copper, in the generator winding had completely melted away, leaving a hole in the iron about 12x18 in. in one place, with several lesser burns in other places. The resulting fire had damaged the field coils and also set fire to the motor, making it necessary to strip both motor and generator for a complete rewinding job. Owing to the severe burning of the iron in the generator, it was necessary to remove all the laminations. In reassembling the core, the damaged laminations were distributed in such a way that they would not be noticeable when the machine was rebuilt. The machine being approximately 22 years old, it was impossible to get new punchings; consequently, the old material had to be used.

Immediately, the service men began stripping the set and preparing it for trucking to the Westinghouse service shop. A large quantity of wire and insulating material was shipped from the East Pittsburgh works of that company. To hurry the work, the winders of the Detroit service shop were immediately reinforced by winders from the Pittsburgh, East Pittsburgh, Indianapolis, and Cincinnati service organizations of the Westinghouse company. After ten days of work night and day the set was ready for operation.

When the repaired set was placed in operation, engineers of both the automobile manufacturing company and the electric manufacturing company were gratified to discover that the machines actually was more efficient than the original set, making a weld in $4\frac{1}{2}$ sec. as compared with the six seconds for the original set—a saving of 25 per cent in time.

Flashing at the Commutator of Direct-Current Machines

By M. E. Wagner

ONE of the difficulties experienced in the operation of direct-current machines is flashing at the commutator. There are different kinds of flashing arising from different causes, some of which may be in the machine, while others are produced by conditions external to the machine. No matter what the cause may be, the flash means that conducting material has been vaporized to form a low-resistance path around the commutator.

What sometimes appears to be an arc around the commutator is conducting material, such as carbon dust, between two or more bars. This conducting material has been made incandescent by current flowing through it from one bar to another. The high speed of the commutator makes the incandescent spot appear as a continuous ring of fire, and is known as "ring fire." If ring fire is allowed to persist, it will carbonize the mica between the bars.

Oil on the commutator may destroy the insulating qualities of the mica in spots, so that these become conductors and will show as ring fire around the commutator. Sometimes the temperature of these spots becomes so high that they appear to explode and are thrown out from the commutator. In some cases these explosions have been known to vaporize sufficient of the copper bars to cause a flashover from one brush group to another. Or it may start an arc that will extend part way across, when it is cooled sufficiently to extinguish it.

Flashovers on a commutator are sometimes caused by heavy overload. These may be of short duration only, but the temperature between the brushes and the commutator may become sufficiently high to vaporize some of the conducting material and the machine arcs over. On large machines these arcs may be quite destructive.

A $7\frac{1}{2}$-hp. motor that came to the writer's attention would flash over at infrequent intervals owing to chattering of the brushes in their holders. The motor was used in reversing service, and sometimes, when its direction of rotation was reversed, the movement of the brushes in their holders would start a small arc that would develop into a flashover. This trouble was cured by adjusting the brushes to a better commutating position.

Machines operating at 500 volts and above are likely to give more trouble from flashovers than lower-voltage machines. When an arc is once started on the former, there is a higher voltage available to sustain it. Furthermore, on the high-voltage machines the arc is likely to be more destructive than on 110- and 220-volt equipment.

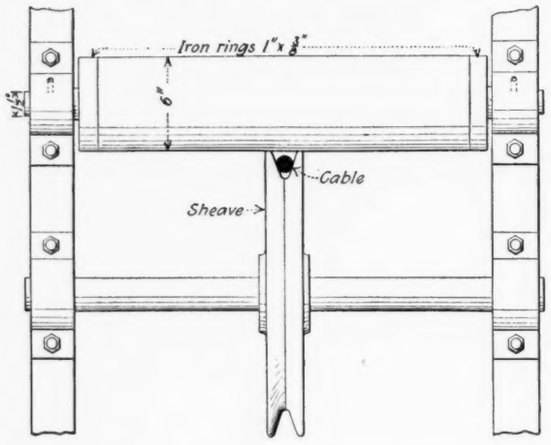
Right Out of the Plant

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

Wooden Roller Used as a Cable Guard

TROUBLE frequently occurred with the cables coming off the sheaves of a hoist when the engine was starting. When they came off, they would be run over the shaft and against the side of the sheaves which, to say the least, was hard treatment for hoisting cables.

The cables were originally protected against coming off the sheave by planks bolted close above them, but



Roller above sheave prevents cable coming off

after a short time the cables would wear deep grooves in the planks and would come off the sheaves.

To overcome this trouble, we made a wooden roller for each sheave and bolted its bearings where the planks were supported. One of the rollers is shown in place in the figure. These rollers are of simple and substantial construction. They reduce the wear on the cables, prevent shutdowns of the hoist and eliminate the dangerous job of climbing the high pulley stands to lift the heavy cables back on the sheaves. A. LEKSTROM.

Ironton, Minn.

Frequent Starting Causes Auto-Starter to Overheat

A 40-HP. induction motor could not be brought up to speed. The fault was remedied, but before this was done the motor had to be started and stopped several times. An auto-transformer was used for starting, which was immersed in oil. It was noticed that the starter was heated to a dangerous degree owing to the frequent starting of the motor. Had this heating not been noticed and the motor again started before the auto-transformer had had time to cool, there might have been serious damage done to the equipment by overheating. In this case no harm was done, as the heating was noticed in time.

An auto-transformer of the usual design is not meant to be operated more than five or six times an hour, without overheating. Auto-transformer type starters should always be carefully watched for overheating, as this is a frequent cause of faults, such as breakdowns in the oil and insulation.

Overheating is often caused if the starter is used too frequently. Another cause is its being installed in a hot place in the motor house. The maker's recommendations concerning installation and frequency of operation should be observed, as different makes of auto-transformers differ in this respect. W. E. WARNER.

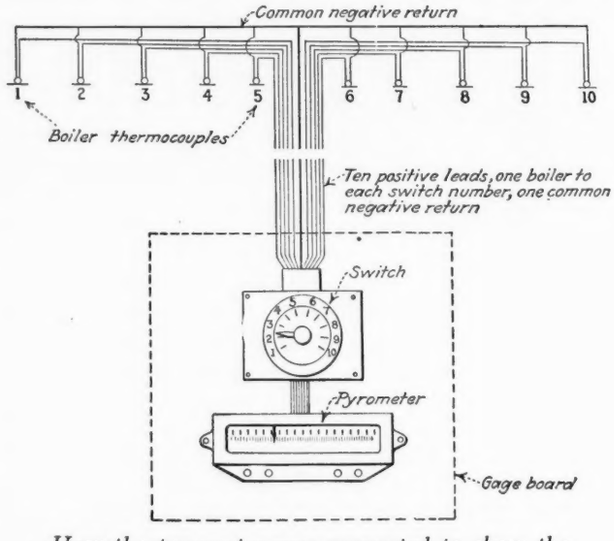
Brentford, England.

Using One Pyrometer for Ten Boilers

IT IS not usually possible to get all the boiler-room instruments one desires at one time, but it may be possible to obtain most of the desired readings by makeshifts, until such time as the other instruments can be worked into the budget.

This was the case in our boiler plant, where we desired to equip ten boilers with all the instruments necessary to insure economical operation. We were able to get our order through for flow meters, but not for the required pyrometers, CO_2 meters, etc. We did, however, finally get an order through for a single indicating pyrometer for checking purposes.

To make the instrument readily available for any boiler, we mounted it with a ten-point switch on a gage-



How the pyrometer was connected to show the temperature at each boiler

board and connected it to the ten boilers as shown in the sketch. By turning the switch to any desired boiler, readings of the flue-gas temperatures at any time are readily obtained.

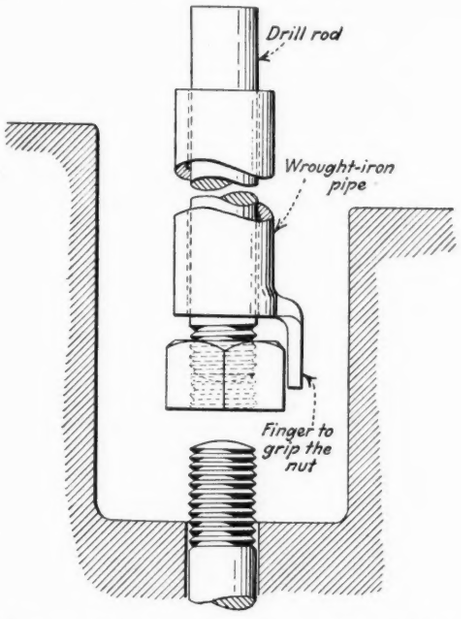
The pyrometer readings were incorporated in our daily log sheets along with the other hourly readings for each boiler on the line. We were thus able to check the operation of all boilers with but one indicating pyrometer.

Pittsburgh, Pa. L. G. JONES.

Tube and Rod Tool for Starting Nuts in Inaccessible Places

GENERALLY, nuts that are to be started in rather inaccessible places are held in open-end sockets, and grease is used to hold them in place while the wrench starts the nut on the stud. This method is good, but a more workmanlike and dependable method of placing nuts on bolts or studs is by means of the tool shown in the illustration.

The center shaft of the tool is a piece of round iron or steel, and the outside is a piece of iron pipe. One



Projection on pipe prevents nut turning, and central rod holds it from dropping while being started on stud

end of the rod is threaded, and one end of the pipe is sawed and made offset, as shown. The nut is engaged on the thread a few turns, then the pipe is slipped over, the projection of the pipe, preventing the nut from turning.

G. A. LUERS.

Washington, D. C.

Long Distance Measurements of Fuel Unloaded or Ashes Removed

THERE are many times when it is desirable around power plants to estimate the amount of coal or ashes handled by skip hoists, cranes, etc., which carry a constant load with a fairly uniform travel. Examples of this are the removal of ashes or the delivery of coal by means of skip hoists; unloading of coal from barges by bucket cranes; filling of boiler hoppers from coal pit by trolley bucket; and so on.

I have frequently found it useful to know just how many loads of ashes were removed each day by the hoist, or how many buckets of coal went to the boilers, or how many buckets were removed from the coal pile, etc. Of course, the amounts handled are converted into tons, so that accurate records might be kept.

A method used by us was the employment of multiple-pen electric time recorders. The pens on the chart are actuated by small magnets, one for each pen, and these in turn are energized through limit switches or contactors located on the moving equipment. Each cycle is indicated by a mark on the chart.

We found that excellent results could be obtained by mounting the contact switches on the drums of the hoists, so that the rotation of the drum would throw the switch in the desired position. The instruments were mounted on the boiler house gage board, visible to the operators.

Each day, when the charts were brought in, the total consumption of coal, coke, etc., was calculated by multiplying the number of trips of the buckets by the capacities of each. Otherwise, it is difficult to obtain these figures, as the hoist operators are taxed with their operation and it is impractical to have a man specially to check the coal unloaded. With regular freight car unloading, where records travel with the cars and the units are so large, the tonnage can easily be watched, but where one desires the amount to any particular service or hopper, this is a practical way of recording it.

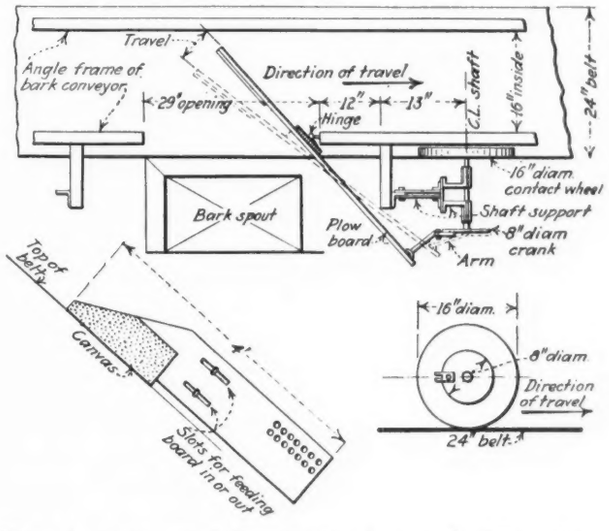
F. M. AHER.

Pittsburgh, Pa.

Improved Method of Distributing Wood Refuse from Conveyor to Furnace

THE problem of bark distribution from a flat-belt conveyor so that a predetermined amount can be discharged into any one of a number of boilers, or so that it can be distributed evenly between them, has been met in a number of ways with varying success. The method which we have adopted as suiting our particular condition and which we find successful, is as follows:

A plow was constructed as shown in the accompanying sketch, which is self-explanatory, so that it could be



Plow is given a wiping motion by crank driven from contact wheel on belt

interposed between the sides of the conveyor trough. It was made adjustable so that it would intercept the refuse to a greater or less degree. To prevent the bark sticking on the nose of the plow, it was given a wiping motion by connecting the end through a suitable movement to the running belt. We use one of the plows for each refuse shoot. A considerable saving was realized and much better results were obtained through better distribution of the fuel.

E. E. BELTER.

Wisconsin Rapids, Wis.

As the Other Fellow Sees It

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Special Pumps in Dunlop Plant

REFERRING to the article describing the power installation at the works of the Dunlop Tire & Rubber Company, Buffalo, N. Y., published in the July 3 issue, I should like to call the readers' attention to some interesting facts that were omitted.

The two motor-driven centrifugal circulating pumps described on page 7, as used with the hot-water pressure installation in the vulcanizing department, are of a special design. These pumps were supplied by the Buffalo Steam Pump Company, of Buffalo, and were especially designed for this type of service, that of supplying high-pressure, high-temperature water. H. H. CLARK,

Buffalo, N. Y. Supt. Engineering Div.,
Dunlop Tire & Rubber Corporation.

* * * *

Surface-Condenser Heat Transfer

I FULLY appreciate Professor Dana's suggestion that condenser design be split up into two parts (*Power*, April 19 and Nov. 15, 1927), but fail to approve his use of the McAdams and Frost data. He uses values that are 35 per cent higher than the experimental data show and proposes risking thousands of dollars in condenser construction based on the results of seven experiments that were not made for the purpose of, or under the conditions of, condenser practice. In fact, in the recent paper, "Heat Transmission From Condensing Steam to Water in Surface Condensers and Feed-Water Heaters," by McAdams, Sherwood and Turner, I do not believe the seven tests upon which Professor Dana places so much faith were even considered.

In the table are listed correct experimental values of K as found by McAdams and Frost, the value of K determined by Dana from some of the same data and the error both in B.t.u. per square foot per degree per hour and as a percentage of the correct value.

COMPARISON OF HEAT-TRANSFER COEFFICIENTS

Run	Velocity, Ft. per Sec.	K Correct Value from Experimental Data	K Incorrect Value Given by Dana	Error B.t.u.	Error Per Cent
1	5.39	598	808	210	35.2
2	6.90	596	803	207	34.7
3	7.16	632	840	208	32.9
4	7.45	642	870	228	35.6
5	3.06	488	679	191	39.1
6	3.31	438	597	151	34.5
7	3.20	443	599	156	35.2

When one stops to consider that in a modern condenser, with a water velocity of about 7 ft. per sec., 35 per cent is a matter of 200 or 250 B.t.u. per hour per degree per square foot, the magnitude of his error is apparent.

McAdams and Frost made seven experimental runs with steam and by means of thermocouples embedded in the tubes obtained data to separate the over-all heat coefficient into three parts—the coefficient from steam to the tube, that of the tube itself and that from the tube to the water. The vapor side coefficient was based on the outside surface of the tube, and the water side coefficient was based on the inside surface.

Professor Dana, without considering the thermal resistance of the tube, an item of about 8 per cent (from their figures), combined the two directly to obtain his value of K, about 35 per cent higher than the true experimental value.

Of course if Professor Dana's article was written before the paper by McAdams, Sherwood and Turner was presented, he cannot be criticized for not using it. This paper does not really bring out anything new or radical, but is a summary of many years of heat transmission research by the group headed by Professor McAdams. The important part of the paper lies in the determination of the factor

$$h_w = Bv^{0.8} \qquad (1)$$

where

h_w = Waterside coefficient;
v = Water velocity in feet per second;
B = Function of tube length, diameter and thickness, and fluidity of the water, which in turn depends upon the water and steam temperatures,

which was first brought out in a paper presented about 1924 or 1925.

As a matter of fact Professor McAdams' equation is of little value to the designer because such factors as tube spacing length and arrangement, vacuum, air-pump capacities and shell design, which must be considered from an economic and engineering point of view, make the use of an over-all coefficient almost imperative. McAdams' equation is, however, important for purposes of analysis and in connection with other heat-transfer equipment. J. J. ALDEN.

Los Angeles, Calif.

* * * *

The Value of Automatic Temperature Control

IN THE effort to secure maximum production of an acceptable sort at the lowest operating cost no expense is spared when providing the right kind of tools or machinery. But, in the final analysis, it is the human element that makes or prevents the proper standard of efficiency.

The production of skilled hands and minds can be substantially increased by maintaining the proper temperature at all times. Sharp contrasts of heat and cold, especially indoors, cause complaint, discontent, nerve strain and lowered efficiency. Besides, there is a definite saving in heat—therefore fuel and money—in the automatic regulation of workroom temperature. It has been demonstrated that around the temperature of human comfort an increase of five degrees means an increased fuel consumption of not less than 16 per cent.

It is my opinion, that a system of automatic temperature control pays dividends big enough to return its original cost in a short time through the savings effected by better health among the men, fewer accidents and less bungling of work. HARRY KAUFMAN.

Philadelphia, Pa.

Propaganda in the Schools

IN THE issue of June 5 Gifford Pinchot charges the electric utility corporations with the attempt to control and corrupt the sources of public opinion, but he does not present data or information that would serve to explain such activities on the part of these corporations.

In my opinion the matter deserves further consideration, and I suggest that Mr. Pinchot furnish the basis of these charges for publication in *Power,* so that the reader may have the facts, which do not appear to be available in such reports as appear in the daily press or other sources.

A. BEMENT.

Chicago, Ill.

* * * *

Can the Engineer Help the Banker?

REFERRING to the editorial in the July 24 issue, "Can the Engineer Help the Banker," a great many bankers do have engineers and will not underwrite an enterprise until it has been carefully investigated and reported upon by engineers. However, I think the present situation is wrong in that, today, many of the industries are the tools of the bankers; whereas, the bankers should be the tools of the industries.

It seems to be the idea that industries, to be successful, must be in the control of the bankers. The bankers handle the industries in such a way as to make large profits in the juggling of securities.

In my opinion a much better situation would be for the industries to go their own way, calling upon the bankers for support when necessary. In short, the banker should be subservient to the industry instead of vice versa.

If this principle had been followed, we probably would not have seen the wrecking of certain railroads.

The bankers are always looking for projects whereby they can get securities to sell at a profit. It would be far better if they would leave the industries alone and underwrite securities when industry finds it needful.

New York City. W. H. ALLISON.

THE direct answer to the question "Can the Engineer Help the Banker," raised in an editorial in the July 24 issue, is an emphatic affirmative. This is not merely a professional attitude, but is soundly founded on facts if we will but analyze the trend of modern industrial development.

There was a time when new inventions were confined chiefly to ideas that were expressed in a product directly used by the general public. To measure the potential general market for the new invention was distinctly a proposition which the banker was ideally equipped to undertake. He was in close and intimate contact with the consuming public, and he could readily gage their ability to absorb and utilize the new product. The banker was well acquainted with the existing competition to be met; for after all, was he not himself an essential consumer?

A gradual metamorphosis in industrial development has set in. No longer is the new invention a basic idea directly applicable to a product for general consumption, but it is rather a process invention applicable to a refinement in design or reduction in cost of the general product. It is in this field that the engineer eminently fits in, for he knows the manufacturing public and its needs and capacities in a manner that it is impossible for the banker to approach even remotely. The enthusiasm of the inventor as to the effect of his invention upon industry, the scope of its application and its potential market must be checked with the cold hard facts of engineering knowledge and experience. The banker cannot hope to understand the technical details of modern inventiveness, and it is but natural for him to call in the engineer to properly evaluate them for him.

The engineer who makes this field his profession, naturally learns to translate his technical information into terms most readily understood and used by the banker. Just as the engineer has reduced the facts of nature to common engineering terms, so the specialized engineer will convert engineering findings into financial statements. The direct result should be a gain in the usefulness of both professions to the investing public.

Philadelphia, Pa. F. M. TUOHY.

* * * *

Combustion Control Formulas

IN CRITICIZING the combustion control formulas in the March 27 issue E. G. Bailey begins by saying: "In the first place 'combustion control' is not in my opinion the correct term to apply to CO_2 recorders, steam-flow air-flow meters or other indicating and recording devices that show operating conditions without actually operating a mechanical control device to maintain proper combustion conditions." In other words, Mr. Bailey would confine the term "combustion control" to mechanical devices installed for the purpose of regulating the air and fuel supply, etc., to bring about the proper results.

Broadly speaking, economical boiler operation, which includes combustion control, rests on the intelligence of the operating engineer, fortified by the information given by the essential graphic records. The essential control data are CO_2, CO, T and $\sqrt{Bd}$ (the square root of the boiler draft). With these four fundamental data before him the operating engineer can make all necessary adjustments intelligently; without them he gropes in the dark. The Bailey boiler-meter cannot be calibrated and adjusted without a knowledge of CO_2, CO, T and $\sqrt{Bd}$. The fact that with the boiler-meter properly installed and adjusted, the operating engineer need not trouble himself about the fundamental data does not detract from their economic importance.

Mr. Bailey is at loss to know why I call the steam-flow air-flow the synthetic method. I call this method of control synthetic because it is the direct opposite of the analytic method. It actually is synthetic because it blends two records into one, which gives information not conveyed by either of the two components separately. Steam-flow record is the index of the rate at which the steam is generated, but it gives no information as to how economically or wastefully the steam is being produced. The air-flow record is an index of the rate at which the air (fuel) is supplied for combustion, but it gives no clue whatsoever as to how much of this air is in excess of what is required for economic combustion, carrying a proportionate amount of heat to waste up the chimney. But under given conditions, by means of the fundamental data the air-flow recorder can be so calibrated and adjusted that its record coincides with the steam-flow record when the predetermined percentage of excess air is supplied for combustion.

I must apologize to the readers of *Power* and especially to Mr. Bailey for the erroneous formula 1,254 + 1,780 × *Ha* = B.t.u. per pound of air burned with natural fuel. How this formula got into the manuscript and how it passed the vigilant eye of the editor, is beyond me to explain. The correct formula is $\frac{Hs}{11.6 + 34.8 \times Ha}$ = B.t.u. = theoretical heating value of one pound of air burned with a natural fuel. The heating value (*Hs*) of the pound carbon fuel unit of the different fuels and the values of *Hs* and *Ha* are as follows:

Anthracite
$HS = 16{,}400$, $Ha = 0.028$

Bituminous
$Hs = 17{,}900$, $Ha = 0.054$

Semi-Bituminous
$Hs = 17{,}600$, $Ha = 0.048$

Sub-Bituminous
$Hs = 17{,}500$, $Ha = 0.047$

Fuel Oil
$Hs = 23{,}600$, $Ha = 0.146$

Natural Gas
$Hs = 34{,}000$, $Ha = 0.314$

Inserting these values of *Hs* and *Ha* of the natural fuels in the formula above, we get the practically correct theoretical heating value of one pound of air when completely burned by the respective fuels.

Anthracite, 1,296 B.t.u.; semi-bituminous, 1,307 B.t.u.; bituminous, 1,328 B.t.u.; sub-bituminous, 1,321 B.t.u.; fuel oil, 1,415 B.t.u.; natural gas, 1,509 B.t.u.

Thus it is seen that the theoretical heating value of air is practically constant when burned with either of the three classes of bituminous coal, it is $\frac{1{,}509 - 1{,}296 \times 100}{1{,}296}$ = 16.4 per cent higher when burned with natural gas than when burned with anthracite. Air is theoretically equicalorific for each class of fuel, but practically the heating value per pound of air supplied varies more than the most variable fuel. The heating value of air varies directly as the ratio of the weight of air supplied to the weight of air actually consumed. For example, if the air supplied to burn bituminous coal is all consumed—that is, completely burned—it will liberate 1,328 B.t.u. per lb., but in actual practice air cannot be completely burned. It must always be supplied in excess. Its actual heating value is determined by the formula $\frac{H\,\text{air}}{1 + \text{excess air}}$ = B.t.u. heating value of one pound of air. Inserting the theoretical heating value of air when burning bituminous coal 1,328 B.t.u. for *H* air and successively the percentages of excess air from 20 to 100 per cent we have

$\frac{1{,}328}{1 + 0.20}$ = 1,107 B.t.u. per lb. with 20 per cent excess air.

$\frac{1{,}328}{1 + 0.40}$ = 949 B.t.u. per lb. with 40 per cent excess air.

$\frac{1{,}328}{1 + 0.60}$ = 830 B.t.u. per lb. with 60 per cent excess air.

$\frac{1{,}328}{1 + 0.80}$ = 738 B.t.u. per lb. with 80 per cent excess air.

$\frac{1{,}328}{1 + 1.0}$ = 664 B.t.u. per lb. with 100 per cent excess air.

These few calculations demonstrate that air is equicalorific only when burning a given class of fuel with a constant percentage of excess air. Not having at hand the paper Mr. Bailey refers to, I am unable to inform myself as to what relation the figures given under the heading, "Flow Effect per B.t.u. for 30 per cent Excess Air" bear to the heating value of the pound of air supplied for combustion. The correct heating values per pound of air supplied with 30 per cent in excess of that theoretically required for complete combustion for the several kinds of fuel is as follows: Anthracite, 997; semi-bituminous, 1,005; bituminous, 1,021; sub-bituminous, 1,016; fuel oil, 1,089; natural gas, 1,161.

The economic control of boiler operation is not an exact science. Many variable factors enter into the process of combustion and heat absorption which cannot be determined with scientific accuracy, so that more or less close approximation must be relied upon. It is a method that can give complete information on all phases of combustion and heat absorption. Reduced to essential factors, its practical application becomes simple, as I have endeavored to show in the articles which recently appeared in *Power*. Unfortunately, these articles had to be abbreviated rather severely. I hope the full text will appear in book form at an early date, so that those interested can get a proper understanding of the true purport of the analytical method of the economic control of boiler operation.

E. A. UEHLING.

Milwaukee, Wis.

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Brighten Up the Boiler Room

IN THE editorial entitled "Brighten Up the Boiler Room," which appeared in the July 10 issue, there are some interesting and instructive thoughts presented on the subject of brightening up the boiler room through the use of aluminum paint.

I have been fortunate enough to see a boiler room that was painted with this highly reflecting material, and there were no dark and gloomy corners in it. Everything, including the hand-rails and floor grating, was painted with aluminum paint.

I believe that the trend away from dark colors in the boiler room is a step in the right direction. A lighter workplace helps the operator to brighter thoughts. Furthermore, as was pointed out in the editorial, aluminum paint will stand up better on hot spots.

The use of light color in the boiler room will greatly aid in the disclosure of dirt, so that its removal is assured. Brighter colors than those ordinarily used in the boiler room will tend to make working therein more pleasant and cause better illumination through greater reflection of light.

These combined results will cause the boiler-room workers to take more interest in keeping the plant clean and in better running order. Also, these conditions are more easily seen. If the worker develops pride in the appearance of the boiler room, he will also develop pride in his work.

I therefore believe that a light gray color, preferably aluminum, should be adopted as a standard color for boiler rooms. The use of light colors on machinery will produce the beneficial psychological effect of stimulating the worker. Also dirt and grease will stand out more prominently on these colors, and the worker will take considerable pains to keep the place clean, whereas dark colors tend to hide dirt so that the operator is not forced to be tidy. Through the use of light colors the appearance of the room will be improved noticeably. The stimulating effect of light color will also prove a factor in the reduction of accidents by keeping the worker keyed-up, vigorous, full of energy and in a brighter frame of mind.

S. KUPPER.

Philadelphia, Pa.

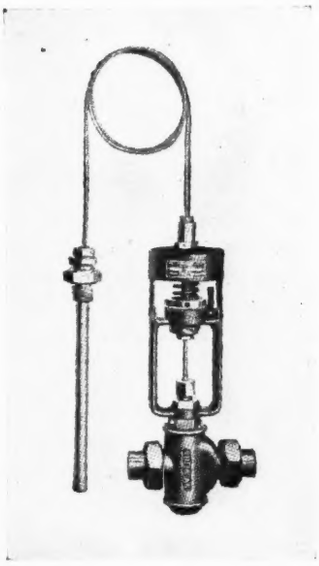
What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Automatic Temperature Controller

THE illustration shows a new type of temperature controller introduced by the American Schaeffer & Budenberg Corporation, 338 Berry Street, Brooklyn, N. Y.

The regulator is a self-contained automatic controller in which a flexible bellows of special design and an operating spring of exceptional large diameter and great length are the important parts. The instrument is made in a number of standard temperature ranges and can be set as desired. The setting point may be adjusted by simply turning a nut which varies the tension of the valve spring and thus determines the pressure required to expand the bellows.



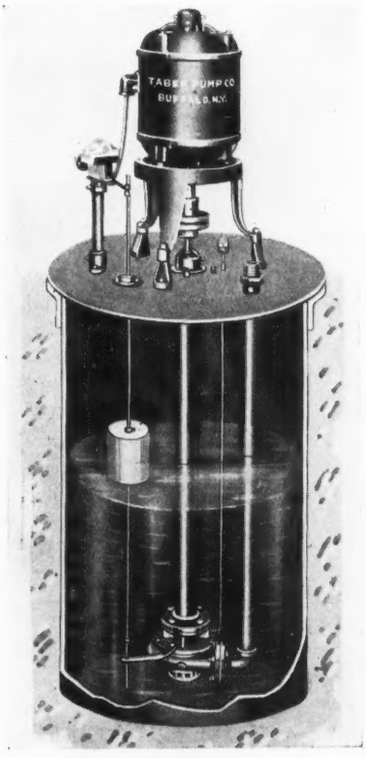
Bellows operated controller

Of special importance is the safety device provided to guard against damage to the bellows from overpressure caused by accidental overheating. This device is in the form of a spring which is placed between the upper and lower parts of the valve stem. If the pressure in the bellows increases after it has completed its stroke, and the valve is seated, this spring will be compressed, thus allowing further expansion.

The controller is particularly suited for hot-water service tanks, water heaters and other similar services where a simple controller is required for close regulation.

Taber L-100 Sump Pump in Steel Tank

IN THE July 24 issue the Midget sump pump No. 2, put out by the Taber Pump Company, 228 Elm St., Buffalo, N. Y., was illustrated and described. Another recent addition to the line of sump pumps made by this company is illustrated herewith.



Sump pump assembly

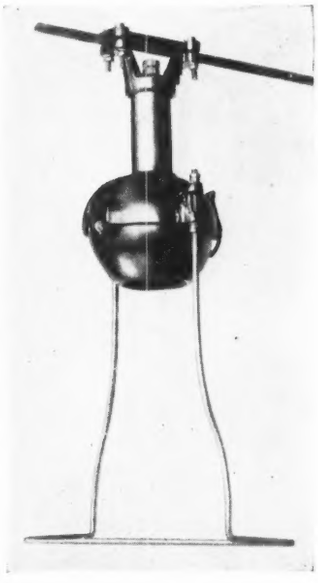
The pump is designed for a capacity of 100 g.p.m. against a 20-ft. head, or to give 75 and 120 gal. at 23- and 14-ft. heads respectively. The motor is fitted with ball thrust bearings, and the pump shaft is carried in bronze bushed bearings, the two shafts being direct-connected by a flexible coupling.

The pump shaft is inclosed, and the pump is supported from the well cover by means of a wrought-iron supporting column. The pump has a bronze impeller and steel shaft. The size of the pump discharge is 2 inches.

Westinghouse Static-Glow Outdoor Potential Detector

A MEANS of indicating potential on high-tension transmission lines at points where no potential transformers are used, is a recent development of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This is accomplished by means of a type O N static-glow outdoor potential detector, illustrated.

The detector consists of a vacuum-type static-glow lamp mounted in standard fuse clips and inclosed in a metal case having a glass window.



Potential detector suspended from line conductor

It is suspended from the line conductor by a clamp in such a manner that the lamp is visible from the ground. One terminal of the glow lamp is connected to the line conductor through the clamp, and the other is fastened to a brass rod antenna suspended from the case. The detector is applicable to line voltages from 4,500 to 220,000.

Arc-Welded Traveling Crane

THE Cleveland Crane & Engineering Company, Wickliffe, Ohio, has brought out a new design of overhead traveling crane in which the bridge girders, end trucks and trolley are constructed by arc welding.

The illustration, Fig. 2, shows a 5-ton, 38-ft. 9¼-in. span crane of the I-beam girder type. Each girder is reinforced throughout its entire length by angles arc welded to the standard I-beam sections. The girders are attached to the end trucks by the notched or shoulder construction designed to prevent weaving. To facilitate shipping the girders and trucks are disassembled. The field connection is made by bolts, but additional arc-welded reinforcement is recommended to secure maximum rigidity.

The end trucks are built up of two standard channel sections joined by welding. Each trolley frame is made of a standard channel with welded braces under each bearing point. Gear guards, as shown in Fig. 1, are arc welded, as are also the bearing supports for the bridge drive shafts. The welding is done by the "Stable-Arc" process.

The advantage claimed by the manufacturer for the arc-welded construction, other than greater rigidity and strength, is more efficient distribution of weight, thus making it possible to lighten certain moving parts and thereby obtain greater acceleration.

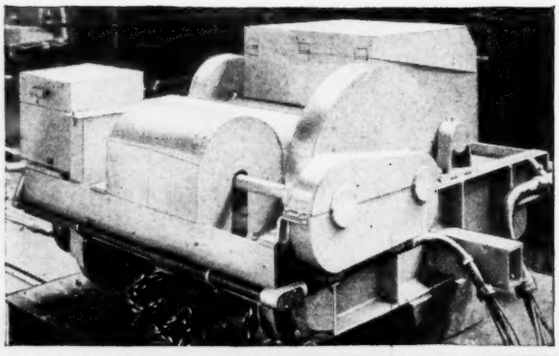


Fig. 1—Welded trolley frame and gear covers

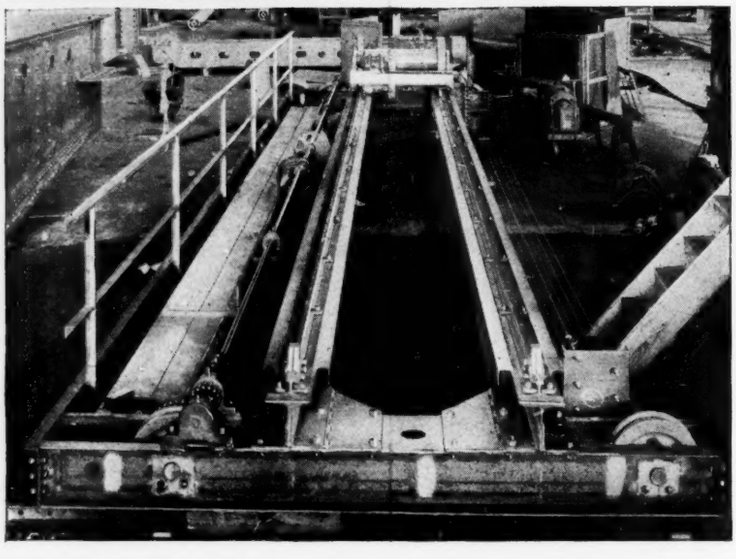
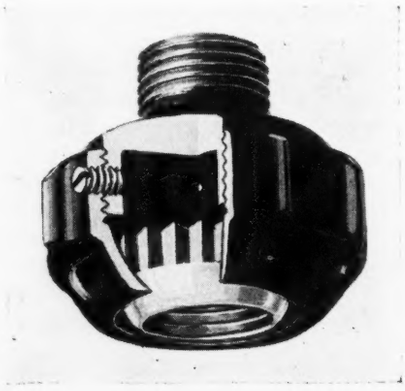


Fig. 2 — Assembly of arc-welded crane

Suspension Joint Fitting for Conduit Wiring

A NEW type of self-aligning suspension fitting for conduit work has just been placed on the market by The Adapti Company, Cleveland, Ohio. This fitting, which is adaptable for use with all standard conduit fittings as well as the Adapti Company's Adapti-boxes and Adapti-lets, consists of a universal joint inclosed in a cast-iron outer shell, as shown in the figure. The upper end carries an external thread to screw into the T-fitting in the conduit run, and the lower end carries an internal thread for attaching to the stem of the lighting fixture which it supports.

The universal joint is so made that it cannot turn, thus protecting the wires that pass through it from abrasion or twisting. It will permit the fixture to swing freely in any direction to the extent of twenty degrees or more, and since the universal joint itself is made of brass, permanent freedom of movement is assured.



Self-aligning fixture fitting swings twenty degrees in any direction, but cannot twist the wires

This fitting assures the proper plumbness of the fixture stem—a matter of particular importance where long rows of pendants are installed. It does this independently of whether the surface wired over is level or not. Furthermore, the pendants are protected against the jarring that would take place with a rigid fitting should the lighting unit be struck by a ladder or through carelessness of a similar nature. It also protects the vertical conduit stem from being bent if, as is often the case, the lamp-maintenance man holds on to it to steady himself when on the ladder wiping out the reflector or changing lamps.

New-Model CoKal Stoker

THOSE concerned with combustion and fuel will be interested in the new model of the Pulverzone stoker known as the CoKal-O-Matic coal burner, brought out by the CoKal Stoker Corporation, Chicago, Ill. The new unit consists of the well-known full mechanical Pulverzone stoker with the addition of automatic motor and damper control included as a complete, integral unit. Automatic starting and stopping are controlled by the steam pressure, which also regulates the coal feed, overfire air and the damper position.

As with the Pulverzone, steam jets operating at not over 5 lb. gage pressure provide turbulence within the furnace while separating the fines from the coarse coal. The fines are

burned in suspension, while the smaller lumps are distributed toward the rear of the furnace, to burn on top of the fuel bed. Turbulence is automatically regulated to be in full operation during the maximum rate of coal feed, while it is shut off when the stoker shuts down. Likewise, the overfire air is controlled automatically by a number of 3½ x 6-in. doors or air ports, so that it is at a maximum when the rate of coal feed to the furnace is greatest.

An interesting feature of the new coal burner is the double-retort-pusher block unit. Each pair of pusher blocks is connected by a T-arm, which has a reciprocating motion, so that one element of the pusher block is feeding coal into the furnace while the other element is moving backward for another charge of coal. The reciprocating motion of the T-arm is obtained from the lower shaft, which operates through an arc of approximately 51 deg. through an L-arm arrangement, giving a back-and-forth motion to the feed connecting rod, which, in turn, is linked up to the connecting bar operating the T-arms. In this way a steady coal feed is maintained, and the rate of feed easily changed by raising or lowering the connecting rod at its pivot point in the L-arm, thus shortening or lengthening the stroke of the pusher blocks.

To protect the retorts or pusher blocks from tramp iron and other foreign matter, each block is provided with a spring unit permitting the T-arm to move its full length while the pusher block remains stationary, if stopped by an obstruction, the spring connection merely closing up in compression. Upon change of direction of the pusher block the obstruction will clear itself, so that the only effect is to stop one pusher block for one forward movement.

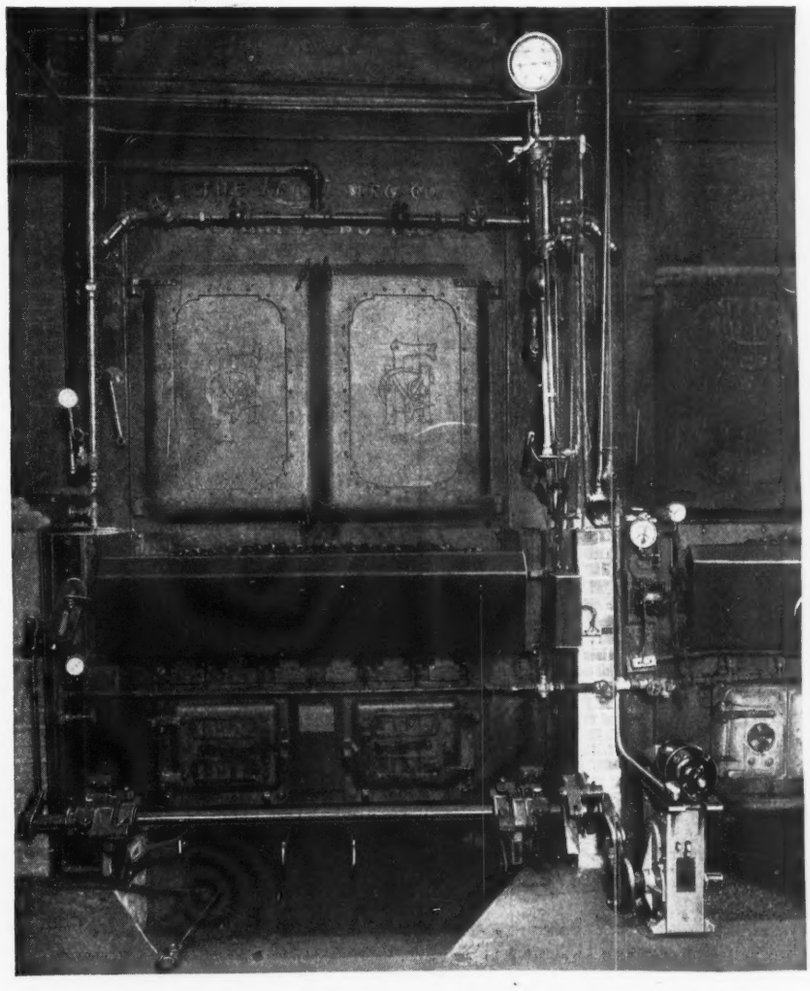
The stoker bars are driven mechanically, so as to advance the fuel downward automatically at definite intervals. The frequency with which they operate can be adjusted by a simple timing arrangement. The stoker shaft is operated by an ½-hp. motor through a gear reducer with 600 to 1 ratio. When desired, the coal burner can be operated without any of the automatic features, a two-throw switch being installed for this purpose, the one position being for full-automatic, full-mechanical control and the other position being for full-mechanical, non-automatic control.

In the illustration are shown two firing doors, which are installed principally as a matter of convenience for burning rubbish, for banking, or to permit access to the furnace for inspection, but they do make it possible to hand-fire during emergencies and thus prevent a shutdown of the boiler plant.

All the important factors contributing to combustion are controlled automatically; namely, the rate of coal feed, frequency of stoker bar action, overfire air supply, steam-jet turbulation and stack damper position. All or any of these can be adjusted independently of the others, and it is claimed that when once the stoker is adjusted for the conditions encountered, it will maintain a good CO_2 at all loads.

These automatic features are governed by an ingenious electrical control that functions according to the boiler steam pressure. When the steam pressure falls below the lower limit for which the pressurestat is set, the circuit controlling the stoker drive motor is closed. The motor immediately starts up, the individual stack damper of the boiler opens, coal begins to enter the furnace as the coal pusher blocks function, the overfire air ports gradually open and the steam jets operate. In due course, and as required, the stoker bars function, moving the coal forward across the grate.

Directly the steam pressure reaches the upper limit for which the pressurestat has been adjusted—that is, as soon as the desired steam pressure has been attained—the electric circuit is opened, shutting off the steam jets, overfire air and gradually closing the damper, so as to retain the heat in the furnace and minimize air infiltration. As this sequence of operation follows automatically, the coal burner is able to operate for long periods without attention. When adjustments of damper position, overfire air ports and rates of coal feed are once made, the air supply is properly co-ordinated with the coal supply at all loads.



CoKal-O-Matic coal burner designed for full mechanical and full automatic control

The General Trend of Modern Development in Steam-Turbine Practice

By Henry Lewis Guy, Assoc. M. Inst. C. E.

This is one of a series of thirty or more papers prepared for the Engineering Conference held in connection with the one hundredth anniversary of the Institution of Civil Engineers of Great Britain. It presents the results of important studies and sets forth the British point of view, which is not greatly unlike that prevailing in this country.

OF THE tendencies affecting the thermal efficiency of steam plants, perhaps the most evident is the pronounced movement toward higher steam pressures. Fig. 1 indicates the savings available and shows that these diminish rapidly at higher pressures.

There can be no real justification for such a variety of pressures as 300, 325, 350, 375 and 400 lb. per sq.in., when the maximum difference in possible thermal efficiency of the extremes from 350 lb. is but 1¼ per cent.

It is doubtful whether at present 350 lb. should be adopted for 50-cycle condensing plants having a lower maximum continuous rating than 10,000 kw., or 550 lb. for less than 20,000 kw.

High-Pressure Turbines Exhausting Into Low-Pressure System

The expedient of installing high-pressure turbines exhausting into an existing low-pressure system is already established. The increased generating capacity is obtained with an increased total coal consumption. If the lower

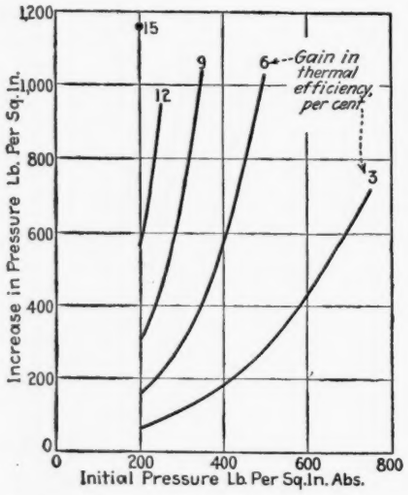


Fig. 1—Gain in efficiency due to increasing initial steam pressure at constant temperature

pressure plant is not reasonably efficient, the more economic course would be either to reserve it for peak loads or to scrap it and to install new equipment at an intermediate pressure.

Reheating by transfer of heat from steam to steam is attracting attention. If, for example, steam is supplied to a turbine at 525 lb. per sq.in. and 750 deg. F., and if 10.25 per cent is condensed in a steam reheater, the final wetness will be reduced to about 6 per cent, with a maximum thermal gain of about 1.9 per cent. If steam is generated at 850 deg. F. and this additional 100 deg. F. is transferred in a reheater following that just postulated, the maximum thermal gain would be raised to 3.3 per cent and the wetness at exhaust reduced to 3.5 per cent. The thermal gain would be slightly greater with no reheating, but with steam supplied at 850 deg. F. Such a reheating system would be employed, therefore, only on the doubtful assumption that higher-temperature steam can be generated and transmitted than steam turbines can be constructed to employ.

Flue-Gas Reheating

There is a decided tendency against reheating by flue gas, at least for pressures below 800 lb. Between 1,000 and 1,500 lb. the disadvantage of flue-gas reheating are minimized and its desirability is increased. The present tendency is to retain flue-gas reheating at such pressures.

Both the advantage and the need of reheating practically disappear if it becomes possible to work at considerably higher temperatures. Thus if 810 deg. F. and 950 deg. F. can be used with initial pressures of 600 and 1,000 lb. per sq.in. respectively, the wetness fraction at exhaust will be the same as with 350 lb. and 700 deg. F.

Unhappily, this recourse of increasing the steam temperature as the pressure is increased is scarcely consonant. The creep of metal probably takes place at all temperatures and increases rapidly with temperature.

The ratio of stresses at 900 and 700 deg. F. for the same rate of creep is about 0.36. For the same factor of safety, based on the creep limit, a pressure of 350 lb. at 900 deg. F. may be equivalent to a pressure of 1,000 lb. at 700 deg. F., but the higher temperature and lower pressure will yield a thermal efficiency almost 2 per cent higher than the high-pressure and low-temperature condition. In a similar way, 250 lb. at 900 deg. is equivalent to 715 lb. at 700

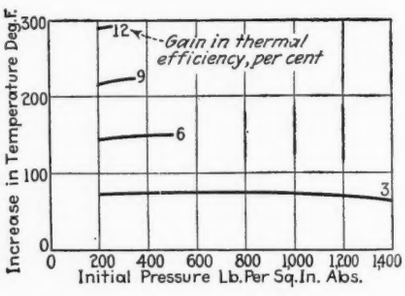


Fig. 2—Gain in efficiency due to increasing initial steam temperature at constant pressure

deg. with an increase of about one-half of one per cent thermal in efficiency.

Although knowledge of creep is not yet extensive or precise, the data used in the foregoing observations are probably accurate enough to justify the conclusion that with equal factors of safety the higher temperature condition will probably give the higher thermal efficiency.

Comparison of Figs. 1 and 2 indicates the relative gains that may be effected by increasing steam pressure with constant temperature, or by increasing steam temperature with constant pressure.. It is evident that much is to be gained through advances in the development of material capable of withstanding higher temperatures.

Regenerative Feed Heating

Regenerative feed-heating has become firmly established. In Great Britain temperatures at the outlets of the feed heaters are being generally raised, and consequently the number of stages is increasing. This is resulting in the addition of air heaters and the retention of the economizer. In some other countries, where elaborations were practiced that were never entertained in Great Britain, the tendency is to-

ward simplification. Feed heaters tend to become fewer, oil and air coolers are being removed from the feed-heating circuit, and economizers show signs of being re-introduced in conjunction with air heaters.

There is a decided tendency to eliminate chemical water treatment and to substitute evaporators, coupled either in parallel with one stage of feed-heating or taking the place of one.

The introduction of feed heaters, evaporators and ejectors introduced a dilemma in the contract definition of performance. It is desirable to give guarantees and to take contract tests with the evaporator cut out or bypassed. The possible systems of stating performance, for given steam conditions and feed temperature, are by steam rate, by heat rate, and by thermal efficiency. The first is perhaps the simplest, whereas the other two will depend upon the steam tables used, and the third also depends on the value adopted for Joule's equivalent. On the other hand, the two latter methods are more closely related to actual coal consumption and have the added advantage that with given variations in steam pressure and temperature and feed temperature, any necessary test corrections are considerably reduced. It is very desirable to reach agreement on the exclusive use of one of these systems.

There is a tendency to return to the system in which the economic rating coincides with the continuous rating, with a much higher rating that may be carried for a short period. This is after some years' experience with the system of maximum continuous rating.

Unfortunately, there is little tendency toward standardization in capacity of units. With interconnection of systems and centralization of control, the necessity for a multitudinous diversity in capacity must surely disappear. The cost of developing a particular size of unit is considerable, and the indefinite multiplication of such charges represents a serious loss. Great advantages would accrue if it could be agreed that one of the following ratings should be standardized for two years for plant extensions: (1) For smaller plants, 20,000 or 25,000 or 30,000 kw. at 3,000 r.p.m. (50-cycle machines) and (2) for the largest stations, 50,000 or 60,000 kw., or larger, at 1,500 r.p.m.

The same would apply if standardization could also be effected for a like period in initial steam pressure and temperature.

To encourage development, some new construction should be deliberately experimental. Stimulated by the example of the purchaser, manufacturers might be induced to pool their resources in order to undertake such experimental plants as a joint effort for the national advantage.

Waste-Heat Recovery Practice

By W. Gregson

Associate Member, The Institution of Mechanical Engineers, England

Industrial-plant efficiencies and, consequently, low operating costs in many industries, depend on waste-heat recovery. Important facts about this method of cost cutting are given in this article, made up of abstracts from a paper by Major W. Gregson, recently read before the Institution of Mechanical Engineers.

APART from early practice on direct-fired forge and puddling furnaces, waste-heat recovery was first effectively attempted on a considerable scale by water-tube boilers, the success of these boilers as rapid heat-transmitters when fired with solid and gaseous fuels naturally leading to their adoption for extracting the sensible heat from furnace gases, etc. In particular, numbers of steel works and cement works were equipped with these boilers prior to the War.

The author first began his waste-heat recovery investigations on pre-war water-tube waste-heat boilers, and as those investigations proceeded one important fact became clear, namely, the difference between the heat-absorption problems involved in "high-grade" waste heat recovery, where conditions approximated to those in solid-fuel firing practice, and in the recovery of waste heat from low-grade gases, such as occur in regenerative furnace practice.

The Importance of Radiation

In the first instance the proportion of heat absorbed by radiation is high, hence the immediate success of the water-tube boiler which is pre-eminently a radiant-heat absorber. In fact, under solid-fuel firing conditions some 70 per cent of its total evaporation occurs through radiation and in the rows of tubes facing and contiguous to the fire. Beyond this zone the evaporation per unit of heating surface falls rapidly, and in general practice the economizer or air-heater or both, if employed, deal with the "tail" of the gases. The fundamental difference in the case of low-grade gases can be clearly understood from Stefan's law, which states that heat absorption by radiation varies as the fourth power of the absolute temperature of the heating medium. Obviously, therefore, a standard fuel-fired design of water-tube boiler applied to a low-grade heat-absorption problem suffers a "delayed-action" process owing to the fact that the radiant-heat absorbing properties of the first section of the heating surface are in operation far below rating; that is to say, the heat transference depends mainly on conducted heat. The result is that for efficient extraction of heat from the waste gases the economizer has too much to do and hence there is a surplus of hot water.

When the radiant heating effect is small, all attention must be focused on obtaining the best possible heat-interchange results by actual conduction; that is, intimate molecular contact between the gas particles and the walls of the heating surface is called for. To enable the water-tube boiler to cope with these altered circumstances when dealing with low-grade gases, it was therefore necessary to place the tubes closer together, particularly toward the back of the boiler, and so to break up the gas stream and enforce close contact between the gas and the tubes. The disadvantages of this arrangement were twofold; it involved a heavy increase of draft drop through the boiler, and it interfered with tube-cleaning on the gas side of the heating surface. The first of these disadvantages unfortunately led to further trouble, which gradually developed when the boiler had been operating for some time. This was due to air infiltration through the casing, adding to the volume to be handled by the induced draft equipment and also cooling the gases enroute through the boiler.

Fire-Tube Boiler Advantages

The great advantage possessed by the fire-tube boiler in dealing with waste-heat problems involving low-temperature gases is readily realized, and a

period of detailed investigation on locomotive boilers was of assistance to the author.

As already stated, where the waste-gas conditions approximate to fuel-firing practice, the water-tube boiler is an extremely effective waste-heat boiler; the only advantages that the fire-tube boiler can claim under such conditions are its smaller size and its ability to stand high draft drops without air infiltration. Where space is not a serious factor, the water-tube boiler can be of suitable dimensions to allow a large heating surface and a low draft-drop, thereby discounting the second of the fire-tube boiler's advantages. With low-grade gases, however, the draft problem becomes acute, as unlimited addition to the heating surface has obvious disadvantages. If the tubes of the water-tube boiler are closely spaced so as to effect continuous contact, the fan power becomes excessive, but the straight-run path of the fire-tube boiler is ideally suited to high gas-velocity practice, resulting in the high heat-transmission rates accompanying the phenomenon of turbulent flow which occurs when certain gas speeds are reached or exceeded.

Some Details That Require Attention

The types of fire-tube boiler unit suitable for both steel-works and gas-works practice are practically identical. The following details need attention in considering individual problems:

(*a*) There is a greater variation in rates of gas flow in a steel furnace plant, particularly in the case of melting furnaces, than in gas-works practice (except in water-gas plants, which are mentioned below).

(*b*) As a rule, tube-cleaning arrangements on the gas side of the heating surface have to be more effective at steel works, owing to the greater difficulties associated with the deposits, due to the presence of hydrocarbons in the producer gas, coal being the fuel instead of coke as in a gas works; and fine dust from the bath and linings of melting furnaces, which tends to congeal.

(*c*) Electrical gear for fan operation, etc., needs more protection on gas-works installations owing to the presence of finely divided coke dust in the atmosphere.

(*d*) Close attention must be paid to such details as flue layouts and proportions, the effective insulation of intake flues, suitable damper gear, and the correct proportion of induced-draft equipment. The last is particularly important where very accurate adjustment is required on the furnaces or retorts. Many waste-heat recovery methods are spoiled by inattention to details of this sort.

(*e*) On water-gas and similar installations, such as complete carbonization units, operating on a "blow" and "run" sequence, the boiler operates under pressure, its resistance being superimposed on the plant circuit, and success in these cases depends largely on burning adequately the products of the "blow" period. Although easily burnt when liberated directly to the atmosphere, these are far less combustible when confined in a flue, as the carbon monoxide often passes in a stream line through the boiler unburnt. The inlet chambers of such boilers must be of special design, with auxiliary secondary-air blast and mixing arrangements to effect complete combustion at the correct period. Again, the intermittent nature of the steam-making period and the varied steam demand call for adequate water and steam space, otherwise cyclic priming and heavy variations in steam pressure occur.

Waste-heat boilers on internal-combustion engines have one feature in common with the last-mentioned class of boiler; that is, they operate under pressure, in this instance superimposed on the engine circuit. Owing, however, to the rapid cooling of the gases passing through the boiler, with a resultant rapid fall in velocity, the back pressure set up by a suitably designed boiler is invariably less than occurs in the standard silencer. This rapid reduction in gas volume makes the waste-heat boiler an effective substitute for the silencer.

As a general rule, comparatively heavy back pressures are permissible in internal-combustion engines; a perusal of the reports of the Marine Oil-Engine Trials Committee demonstrates this point. Hence a closely spaced water-tube or thimble-tube boiler can, under these conditions of service, be very effective, as good contact-heating is not prejudiced by high resistance to gas flows.

Auxiliary Firing

The question of auxiliary firing occasionally arises in connection with waste-heat recovery plans. With a fuel-fired design of boiler this is readily arranged for the full rating on a heating surface basis, and even on a boiler designed purely for waste-heat recovery, alternative firing, producing an evaporation figure equivalent to the output on waste heat, can readily be applied. Such a boiler, however, is inherently unsuited for heavy fuel firing with correspondingly high increases in evaporation per unit of heating surface, on account of the ease with which it could be overforced. Undoubtedly, the simplest and best arrangement, especially in a large works, is to install an auxiliary boiler or set of boilers designed for solid-fuel firing, and by keeping the two sections entirely separate to get the best all-round results.

Carbonizing Plants

Practice has shown that the normal gas works can meet the whole of its power and process requirements by means of waste-heat steam, and in this instance it must be remembered that comparatively small power units, with consequent low efficiencies, are involved. In the author's opinion the electricity supply and the gas works in every town should be interlinked and under one control, such an arrangement having many advantages. The general scheme would be to use all coke breeze, and any other coke not required for sale, in high-pressure boilers; waste-heat recovery would be employed at medium pressures (to obtain the best quantitative results), and the steam from the two sources would be combined in mixed-pressure turbines, "bleeding" low-pressure process steam. All works services would, of course, be electrified.

The gas works of Great Britain carbonize some 16 million tons of coal per annum. Assuming that this coal uses 14 per cent of its weight of coke for carbonization, the total annual consumption of fuel-coke is 2,240,000 tons. With settings properly arranged for waste heat recovery, four tons of steam per ton of coke would be an average figure to represent both modern vertical-retort practice and modern regenerative horizontal-retort practice. Therefore, nearly 9,000,000 tons of steam would be available. Before the advent of waste-heat recovery practice, gas-works steam was generated from the coke breeze at, say six tons of steam per ton of breeze. Therefore, waste-heat recovery adopted throughout these works would represent 1,500,000 tons of coke breeze saved for other purposes.

In dealing with both steel plants and carbonizing plants, the subject of waste heat recovery is, of course, closely interlinked with the complementary subject of the effective utilization of the steam. Each individual works has to be properly reviewed before the best all-round solution can be found. Low-pressure steam from turbines for process work, steam accumulators to balance supply and demand, and the elimination of small isolated heat engines as prime movers are among a number of salient features in this aspect of the subject.

Two-Stage Generation

An important problem in connection with waste-heat recovery from the technical point of view is that associated with steam generation in two stages. The advent of the big-unit boiler fired with pulverized fuel and generating steam at a high initial pressure would appear to be best met by two-stage steam generation. The main boiler would be a high-pressure water-tube unit, designed chiefly for radiant-heat absorption, and would be followed by a secondary boiler of waste-heat design, operating at low pressure. The steam from this would be used for feed heaters, evaporators, degasifiers, etc., and any surplus would be used in the low-pressure stages of the turbines. The superheater would be interposed between the two boiler sections. Such an arrangement appears to eliminate many of the complications at present associated with large-output high-pressure units and incidentally provides (in the low-pressure boiler section) a potential method of thermal storage.

The principles underlying waste-heat recovery apply equally to all branches of industry involving heat processes, such as cement manufacture, brick and pottery manufacture, metallurgical works of all kinds, chemical works, etc.

If engineers responsible for the design, construction and operation of the heat-using apparatus mentioned in this paper will appreciate the extent to which heat otherwise wasted can be returned to the credit side of the balance sheet, they will take adequate steps to utilize it after it has fulfilled its primary function, and they will also endeavor to lower the percentage of heat lost through other channels which do not admit of effective recovery.

RECENT PUBLICATIONS

MINERAL RESOURCES OF THE UNITED STATES, 1925. By Frank J. Katz. Published by the United States Government Printing Office, Washington, D. C. Cloth; 9x6 in.; Vol. 1, 768 p.; Vol. 2, 615 p.

THESE volumes contain an immense amount of statistical data regarding the amount of minerals mined, their value, the known deposits in the United States and in foreign countries. In addition, useful information is given regarding the properties and uses of the various minerals mined. Volume 1 deals with the resources of metals and Volume 2 deals with non-metals.

THERMODYNAMIC PROPERTIES OF OXYGEN AND NITROGEN. By Russell W. Millar and John D. Sullivan. Technical Paper 424, United States Bureau of Mines, Washington, D. C. Paper; 6x9 in.; 20 pages; two large charts. Price, 15 cents.

THIS paper discusses the need for information on the properties of nitrogen and oxygen in the region of pressures and temperatures involved in liquefying these gases. Tables are presented for the properties of saturated and superheated vapor, from temperatures ranging from 80 to 300 deg. Kelvin. Two large Mollier charts with pressure and heat content as co-ordinate axes, exhibit the saturation dome and lines of constant temperature, constant entropy, constant volume and, in the wet region, constant quality. The paper should be useful to those who are concerned with the high pressure compression and liquefaction of gases.

SUGGESTIONS FOR THE PRACTICE OF COMMERCIAL ARBITRATION. Prepared by The American Arbitration Society. Cloth; 241 pages. Price, $1.85.

FOR the first time in the history of commercial arbitration in the United States a practical handbook on the subject has been prepared by the American Arbitration Association and published by the Oxford University Press, American Branch.

The book is prepared in a style which is non-technical and which the average business man can easily follow. Such questions as whether a dispute is arbitrable, whether fees should be paid to arbitrators, how to manage arrangements for arbitrations, when hearings should be waived, whether an arbitrator is qualified to act, how to draw a submission, what the arbitration law requires, what records should be kept—and a host of others are taken up and answered in simple and direct fashion.

Complete annexes to the book cover local and national practice, a digest of all state arbitration laws and leading decisions under the New York Arbitration Law. Arbitration Rules of the American Arbitration Association under the New York Law and those applicable generally, are given, as well as a Draft State Arbitration Act and a Table of Cases covering almost 150 decisions.

BITUMINOUS COAL FIELDS OF PENNSYLVANIA. Coal Resources. By John F. Reese and James D. Sisler. Topographic and Geologic Surveys—Bulletin M6, Part 3. Published by the Bureau of Publications for the Commonwealth of Pennsylvania. Paper; 6x9 inches; 153 pages.

THE original computation of bituminous coal reserves of Pennsylvania was the work of John F. Reese, a mining engineer widely familiar with the coal fields of western Pennsylvania. A summary of the results was published in mimeograph form as the computation in each county was completed. This bulletin presents all the data which were contained in the mimeograph reports, and additional detailed information. It should be of value to state and county officials, mine operators, mining engineers and students of minerals conservation.

NEMA HANDBOOK OF APPARATUS STANDARDS.—Published by the National Electrical Manufacturers Association, 420 Lexington Ave., New York City, 1928. Paper; 6x9 in.; 348 pages. Price, $3.

TEST, performance and manufacturing standards of electrical apparatus have just been published as the "NEMA Handbook of Apparatus Standards," formerly known as the "Electric Power Club Handbook of Apparatus Standards." The book embraces standards of electric power, control and measuring apparatus for the generation, distribution and utilization of electric energy.

Each section of the handbook, covering such apparatus as motors and generators, industrial control, transformers, switchgear, measuring instruments, electric welding, etc., is complete in itself, all the rules relating to each product being grouped together. Standard definitions, abbreviations and symbols are also included for each class of apparatus.

The question of how long a manufacturer should keep tools and patterns for supplying customers with spare parts is covered fully under the heading "Business Policies," together with customer's obligations in this connection.

Under the heading "Application and Selection of Rotating Apparatus," the proper service factors are given. These are multipliers to be applied to the horsepower ratings of standard motors for use in special applications or under special service conditions which are also defined. Full information is given regarding the effects of variation of voltage and frequency upon the performance of induction motors. This information is especially valuable for the application of standard motors on the off voltages of some of the network distributing systems being installed by electric light and power companies.

American standard connections and terminal markings of motors, generators, converters and transformers are given in full. The section on Industrial Control includes the rules approved as "American Standard," by the American Engineering Standards Committee, with additional standards and recommendations adopted by NEMA and not yet presented to the American Engineering Standards Committee for adoption.

Power, distribution and instrument transformer standards are given in full. The section on switchgear includes standards for the manufacture, test and performance of power switchboards, oil circuit breakers, safety inclosed switchboards, automatic switchboards, high-voltage switching equipment and fuses. Forms are also given standardizing the information to be furnished the purchaser with specifications in proposals for this equipment.

Ratings of direct-current arc-welding sets are specified, together with the test and performance specifications which these sets should meet.

EMBRITTLEMENT OF BOILER PLATE. By Samuel W. Parr and Frederick G. Sahub. Published by the Engineering Experiment State, University of Illinois, Urbana, Ill. Paper back; 6x9 in.; 67 pages. Price, 40 cents.

THE boiler users and manufacturers owe much to the authors of this book, to whose efforts much of our knowledge of the causes of embrittlement of boiler plates is due. As the authors point out, the fracture of boiler plates began to be noticeable several years ago when feed-water treatment became general. Apparently, the trouble can be traced to the existence of sodium carbonate in large quantities without the presence of sodium sulphate. The book discusses the investigations made and gives instructions as to the precautions to be taken.

WATER RESOURCES PAPER NO. 54—The Dominion Water Power and Reclamation Service of the Department of the Interior of Canada has recently issued Volume 54 of the Water Resources Papers which deal with the surface water supply of Canada. This number contains the results of investigations made by the Dominion Hydrometric Survey during the climatic year Oct. 1, 1925, to Sept. 30, 1926, in the provinces of Alberta, Saskatchewan and Manitoba and the extreme western part of Ontario. The report contains a short explanation of the purpose and scope of the work and 278 pages of stream-flow and meteorological data, with an index map showing drainage areas and the location of gaging stations. Copies may be obtained free of charge on application to the Director of the Dominion Water Power and Reclamation Service, Ottawa, Canada.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Boiler Explosion on Lighter Kills Three and Destroys Vessel

THE cause of the boiler explosion which on July 31 wrecked the floating derrick "Chancellor" and sank her almost instantly at her Edgewater Street pier, Stapleton, Staten Island, with the probable loss of three lives, is still undetermined, according to officials of the Merritt-Chapman & Scott Corporation, her owners.

The Chancellor underwent her annual inspection at the hands of United States Steamboat Inspectors Saturday, July 28, was found to be in excellent condition and received a renewal of her certificate. Sunday intervening, she had not since been in service, although steam was raised in the boilers July 30 and everything tested out satisfactorily.

William Wood, the vessel's engineer, who was in personnal charge of the engine room at the time of the disaster and now is missing, had been twenty years in the service of Merritt-Chapman & Scott and was one of the oldest and most trusted employees of its mechanical staff. Mr. Wood was 53 years old and a resident of Brooklyn; he is survived by his widow and one son.

The "Chancellor" was built in 1910 at the Tottenville, S. I., yards of A. C. Brown & Sons. She was known as a self-propelled steam derrick, 387 gross tons, 187 net tons, and was 136.8 ft. long over all, 37.1 ft. beam, and 11.6 ft. deep. Her main boiler had 5,500 sq.ft. of heating surface, and was of the return-tube type, designed to generate steam at 160 lb. pressure. The vessel was especially equipped by her owners for the heavy service in which she worked and had four water-tight bulkheads, greatly increasing her strength. Her hoisting engines were capable of lifting 18 tons dead weight, and the boom reach was approximately 100-ft.

The "Chancellor" was one of three vessels of her class, two of which are in continuous service about the harbor, while a third is kept in reserve; facilities for service, therefore, are not hampered. Hardly any of the near-by vessels escaped injury. When the heavy boiler of the "Chancellor" was shot skyward by the blast, it alighted with a crash on the wrecking steamer "I. J. Merritt," anchored on the other side of the dock 150 feet away, piercing its deck; the base of the boiler in its flight dropped to the deck of the wrecking steamer "Relief," inflicting a similar injury; the topmast of the latter vessel also was torn away and the wireless antennæ were wrecked on the "Merritt," the "Resolute," the "Willett" and the "Relief." The steam lighter "Corporal" was the worst damaged of the near-by vessels, as the boom of her derrick was broken off at the base and driven back about fifteen feet into her house, practically demolishing it. A new boiler, lying on her deck ready for delivery to an outbound vessel for shipment, also was struck by flying fragments and is a complete loss. The mainmast of the wrecking barge "Chittenden" was broken off within six feet of the deck and half of her foremast was cut off. Adjoining buildings, also, were seriously damaged.

No definite estimate of damage can be made until completion of the surveys now being carried on by engineers and divers of the company, which will occupy some time. According to officials of the company, the value of the "Chancellor" at the time of the wreck was $125,000. The "Corporal" is valued at $25,000.

Permit Granted for 260,000-hp. Development on Tennessee River

The Federal Power Commission has announced authorization to the Mississippi Power Company, subsidiary of the Alabama Power Company, for a power project on the Tennessee River near Riverton, Ala.

The project includes a gravity section concrete dam at Cook's landing, forming a reservoir extending 63 miles upstream to the base of the Muscle Shoals dam and flooding out the existing government lock, dam and canal at Colbert Shoals, near Riverton. The proposed initial installation is 100,000 hp. and the maximum 260,000. Major-Gen. Jadwin, who recommended issuance of the permit, indicated recently that the interests of navigation might best be served by constructing a power and navigation dam at the Pickwick landing site, about eleven miles farther downstream than the site proposed by the company. The chief of engineers recommended the permit be issued, subject to the condition that a complete engineering, economic and financial report on the Pickwick landing site be prepared by the permittee, and this recommendation was included in the commission's authorization.

Two municipal hydro-electric projects were also subjects of favorable action by the commission at its last meeting. A license was authorized for a development by Crisp County, Ga., and a preliminary permit was given the City of Allegan, Mich. In the latter case the preliminary permit was granted the municipality when a conflicting application of the local power company apparently provides for a more comprehensive development than the City of Allegan could attempt. The provision in the law according priority to municipalities evidently was considered by the commission to be sufficient to outweigh the advantages of the better development the private company was in position to provide.

In the Crisp County case there was no conflicting application, but the power is to be furnished in an area now being served by a private company which is in a position to furnish efficient and economical service and to meet all requirements.

World's Largest Boilers For East River Station

The New York Edison Company through its consulting engineers Thomas E. Murray Incorporated, New York has placed an order with the Combustion Engineering Corporation for four complete pulverized-coal-fired steam generating units, each containing 40,700 sq.ft. of boiler heating surface and 4,420 sq.ft. of heating surface in the furnace. The aggregate of 45,120 sq.ft. of heating surface per unit will make these the largest units in the world. Each unit is guaranteed to produce 550,000 lb. of steam per hour, but sufficient forced and induced-draft fan capacity will be installed to permit the operation of these units at peak productions of up to 800,000 lb. of steam per hour.

The boilers will be of the double Ladd type and will be designed for a maximum pressure of 500 lb. and an operating pressure of 425 lb. The furnaces will be equipped with C-E fin tubes in all four walls, fin-tube arch screens and Lopulco water screens. Ten Lopulco, Couch-type, burners will be installed in each furnace, five in either side wall. The coal will be fed to the burnaers by ten Lopulco, type-R feeders. Eight C-E air preheaters will be installed, two for each unit. Each preheater will have a total heating surface of approximately 35,000 sq.ft. The order also includes four No. 25 Raymond super-mills replacing four screen-type mills now in service.

The new boilers will furnish steam for the 180,000-kw. generating unit now on order and have been specially designed to fit the limited space condition and to assure a steam product of approximately 2,000,000 lb. per hour.

Capacity of Bryson Power Development Increased by 25,000 Hp.

TO ITS already extensive possession of hydro-electric power developments in Canada the International Paper Company recently added what is known as the Bryson plant, on the Ottawa River. This plant, which has an installed capacity of 25,000 hp. and a possible development of 75,000 hp., was built a comparatively short time ago by the Ottawa & Hull Power Company. The new owners expect to be generating 50,000 hp. by November of this year, by which time an additional 25,000-hp. unit now being installed will have been turned over and ready for operation.

The Ottawa River at a point near the village of La Passe is divided into two channels by the Island of Grand Calumet, the westerly course being known under the name of Rocher Fendue Channel and the easterly course under the name of Calumet Channel; and at a point some 22 miles downstream from the point of division near the village of Bryson, there occurred, over a distance of a little more than one-half mile, through a rocky gorge interspaced with a number of small islands, a series of rapids having an available head of 60 feet.

The Bryson development looks like this to an aviator

The watershed tributary to the Ottawa River at Calumet Falls is 27,914 square miles in extent. Careful water gagings of the Ottawa River had been taken and accurate records preserved by the Department of Public Works for the past twenty years or more, and, based upon these, the minimum flow of the river at the point of division of the channels was accepted as being 11,700 sec.-ft.

The first actual development work to be undertaken consisted of the construction of the main cofferdam at the head of the rapids. The greatest depth encountered in this work at this point was not in excess of 20 ft. and no unusual difficulty was experienced in satisfactorily shutting off the flow of this channel.

The main dam is immediately above the foot of the rapids, at a point where the river was relatively shallow, and advantage was also taken in the construction, of including a certain portion of an island in midstream. A restriction occurred in the bed of the river at this point, rendering the cross-section quite narrow, but on account of the large spillway area required to discharge the spring floods, the entire crest area was needed for this purpose, and in consequence the power house was not included as an integral portion of the dam, but was situated some little distance downstream and connected by a canal excavated along the western bank.

The dam is a concrete gravity section 380 ft. long and 70 ft. high, containing twelve sluices and a log slide of V-section, all covered by a reinforced-concrete deck. The sluices are all 20 ft. in width, with the crest of the dam at elevation 321, which with the normal operating level at elevation 350 places the depth of the sill below high water at 29 ft. The water level is controlled by stop-logs, handled by a 30-ton traveling stop-log hoist electrically operated by direct current supplied at 220 volts by a series of outlets placed on concrete pedestals along the downstream edge of the deck. The eastern abutment of the dam is built into and against a high bank of solid rock, and the western abutment stands alone and forms the commencement of the downstream wall of the canal which was excavated to carry the water to the forebay.

The unit is controlled by an oil-pressure governor driven through bevel gears from the turbine shaft, equipped with the usual hand-controlled mechanism, gate-opening indicator, adjustable gate limiting and the usual safety shutdown devices operating on two motors direct connected to the gate ring.

The initial installation at this plant consists of one vertical-shaft turbine unit capable of developing, when operating under a net head of 60 feet, a total output of 25,700 hp., or 22,500 hp. at $\frac{7}{8}$ gate opening at a speed of 120 r.p.m., the runner being of the usual Francis type and with a guaranteed efficiency when operating at $\frac{7}{8}$ gate opening of 88 per cent.

The generator is connected, through a low-voltage oil circuit breaker, directly to the low-tension side of a bank of three 7,500-kva., oil-insulated, water-cooled, shell-type, single-phase, 41,600/6,600-volt indoor-type transformers, there being no low-voltage buses between the generator and transformer. The transformer rooms are isolated by firedoors and similar protection against fire has been made throughout the building.

Harvard Uses Moving Pictures For Engineering Education

The motion picture will enter the field of industrial education on a large scale next fall, when the Harvard Graduate School begins the use of films in its courses in engineering, industrial management, advertising, foreign trade and accounting.

Bringing the processes of industry into the classroom by means of films will bridge the gap between theory and practice, according to Assistant Professor H. H. Thurlby of the Harvard Business School. At present, Professor Thurlby, in behalf of the University Film Foundation, is gathering industrial films from the 350 concerns that have taken movies of their plant operations. Copies of these will be re-edited by the Foundation and made available to Harvard and many other colleges throughout the country.

"A surprising number of students at Harvard," says Professor Thurlby, "come from farms and small communities and have never seen the inside of a large factory or power plant. We can teach no end of theory to such men, but observation of the wheels of commerce in actual operation is necessary to make their imaginations fully take hold. Engineering problems, for instance, become much more real when the movie shows the operations of oil refineries or steel mills.

"Many factories, advertising firms and banks have had the foresight to realize how the movie can explain their activi-

ties, better than words, to the public. We find these firms eager to assist in the education of future executives by letting us have copies of the many industrial films. It is an innovation that holds infinite possibilities in engineering and business education."

The University Film Foundation is operated in collaboration with the Faculty and Staff of Harvard University for the production and collection of educational films. Motion pictures of plant and animal life, the habits of the peoples of the earth, the processes of wind and water erosion of the earth's surface, and other subjects particularly fitted for movie presentation will be filmed by the Foundation and gathered into a great film library in connection with Harvard. The industrial films are merely the beginning of the Foundation's activities, through which it is hoped to make the movie a vital adjunct of education not only for college students, but also for children of school age and for adults who are unwilling to have their mental growth end with the completion of formal education.

W. L. Sibert Chosen Chairman of Boulder Dam Commission

One of the most important duties of the Boulder Dam Commission is to form a conclusion as to the extent to which earthquakes constitute a practical hazard to dams in the lower Colorado River. This opinion of W. J. Mead, the professor of geology at Wisconsin State University, and a member of the commission, was expressed after the initial meeting of the commission in Washington, July 30.

Little was done at this meeting other than organization. Maj. Gen. William L. Sibert, retired, was chosen by his fellow members to be chairman. Charles P. Berkey, one of the geologists on the commission, was elected secretary. Offices for the use of the commissioners were made available in the Bureau of Reclamation. It is expected that the commission will leave Washington Aug. 15, for Denver, where a further study of existing engineering data will be made. After that the commission will visit the dam site. It is then expected that a further study will be made of records in Denver, after which the commission probably will return to Washington to formulate its conclusions and write its report.

Former Secretary Work, who appointed the commission on instructions from Congress, in remarks at the organization meeting indicated that he does not believe any further engineering study is necessary, but assured the members of the commission that officials of the Department will be ready and willing to weigh any new evidence that the commission may unearth. The big question for the commission to decide, in Doctor Work's opinion, is whether or not it is feasible to construct such a dam under physical conditions such as exist in Boulder Canyon.

Roy O. West, the new Secretary of the Interior, assured the commission at its public session that every facility and resource of the Interior Department would be at its disposition. There is no agency in the government more anxious to see the Boulder Dam question solved, and solved properly, than the Interior Department. Secretary West suggested that Dr. Elwood Mead, the Commissioner of Reclamation, could be of great help to the members of the commission because of the complete grasp he has of problems involved in this outstanding project.

Coming Conventions

American Society of Mechanical Engineers, Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3; second national fuels meeting at Cleveland, Ohio, Sept. 17-20; Calvin Rice, secretary, 29 West 39th St., New York City.

Canadian Steel and Power Show at the University of Toronto Arena, Sept. 4-7; Campbell Bradshaw, secretary, 24 Front St., West Toronto, Canada.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Blvd., Chicago.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

New York Power Show (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

New England Water Works Association, annual convention at Montreal, Canada, Sept. 18-21, Frank J. Gifford, secretary, 715 Tremont Temple, Boston, Mass.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

Universal Craftsmen Council of Engineers, annual convention and power engineering exhibition to be held at Newark, N. J., Aug. 7-10. Secretary, O. R. Young, 150 Nassau St., N. Y.

World Power Fuel Conference at the Imperial Institute, London, Sept. 24 to Oct. 6.

A. De Forest, Research Engineer, Wins Dudley Honor Prize

Alfred V. de Forest, research engineer for the American Chain Company, was recently honored by the National Society for Testing Materials, which organization awarded him the Dudley National Medal in recognition of his achievement in perfecting a non-destructive test for materials. With the device Mr. de Forest has developed, it is now practical for any young woman to sit in front of a machine and, by means of a graph on which appears a hysteresis loop, determine instantly whether the material passing in front of her has the slightest defect.

Magnetic analysis is a subject on which dozens of eminent research engineers have been working for years. Now the problem has been solved through Mr. de Forest's sensitive electric galvanometer, which will detect a flaw no bigger than a pinhead in the center of a large steel wheel without cutting or marring the surface of the metal.

In operation the galvanometer is comparable to the X-ray which penetrates the tissues of the human body without harming them. With the newly developed instrument a plate or piece of steel five or six inches thick may be explored almost as though it were made of glass.

This invention will have a far-reaching effect on the quality of all materials used in industrial machinery. As an instance, just one of the important uses to which it may be applied is the inspection of steam-turbine wheels. Such wheels with their buckets frequently operate at speeds upward to 3,600 r.p.m., and should a flaw deep in the center of the steel of which they are made cause a section to fail, the resulting destruction would be terrific. Countless other equally important applications await its production.

Mr. de Forest graduated from Massachusetts Institute of Technology in naval architecture in 1912. He was with the New London Ship & Engine Company for one year, after which he became instructor in civil engineering at Princeton. He later studied metallography at Columbia, then spent two years in the research department of the Remington Arms Union Metallic Cartridge Company. Since 1918 he has been chief research engineer for the American Chain Company, his activities extending to the products of all the American Chain associate companies, such as the American Cable Company, Page Steel & Wire Company, Manley Equipment Company, Reading Steel Casting Company, Dominion Chain Company and others.

Federal Trade Commission Starts Investigating Utility Finance

The Federal Trade Commission is actively at work on the second phase of its public utilities investigations. Twenty-six of its representatives are busy taking pertinent information from the books of a number of the large holding companies. The remaining phases of the inquiry, the commission says in its monthly progress report, call for a high degree of specialized knowledge and experience. The staff of the commission has been augmented by a number of accountants with experience with state utility commissions.

Of the 10,211 questionnaires sent out at the beginning of the investigation to the privately owned utilities, 5,944 returns have been received. It has been learned, however, that a considerable number of the companies originally addressed have retired from business or have been absorbed by other companies or are not public utilities. It is estimated that less than 2,000 companies actively engaged in the utility business are still to be heard from.

OBITUARY

J. RUSHING SHINAULT died at his home in Oxford, Miss., on July 24, after an illness of three weeks. Mr. Shinault installed Oxford's first power plant and telephone system, and was for a number of years superintendent of the power plant at the University of Mississippi.

FREDERICK WINTERS GRIFFITH, president, treasurer and member of the board of directors of the Garlock Packing Company, Palmyra, N. Y., died July 11 at his home in Pasadena, Calif., in his 70th year. Mr. Griffith was born at Phelps, N. Y., and received his education in the public schools and was graduated from Hamilton College. He was one of the founders of the Garlock Company and has helped supervise its activities for over a period of forty years. He was preparing to make a trip to Alaska at the time of his death.

PERSONALS

CLAUDE HARTFORD has been elected vice-president of the American Elevator & Machine Corporation with headquarters at 113-115 Cedar St., New York City. Mr. Hartford has resigned as manager of the Industrial Relations Department of the New York Steam Corporation, with which public utility he became associated in July, 1913, serving successively as assistant to the chief engineer, superintendent of the district embracing the lower portion of Manhattan, and engineer, contract department. Mr. Hartford received his engineering education at Stevens Institute of Technology and Cornell University, and was graduated from the latter institution in 1910, with the degree of mechanical engineer. He is a member of the American Society of Mechanical Engineers, having been elected in 1912.

DR. GERHARD DEHNE, of Berlin, has been appointed a member of the Managing Board of the Second World Power Conference, to be held in Berlin in 1930.

D. MCLEAN, formerly Deputy Minister of Public Works for Manitoba, Canada, has been appointed hydro-electric commissioner for that province. Mr. McLean, who is a graduate from the McGill University in 1919, has had a wide experience in electrical engineering, in the course of his career having been in charge of many undertakings.

BUSINESS NOTES

THE PAUL B. HUYETTE COMPANY, INC., 5 South 18th Street, Philadelphia, Pa., has been appointed by The Engineer Company, of 17 Battery Place, New York City, as its representative in the sale of Enco baffles, combustion control and oil burners. The territory allotted includes Philadelphia and vicinity, Baltimore and Washington.

SPENCER TURBINE CLEANER COMPANY, 101 Park Avenue, New York, announces the appointment of Frank Martin as vice-president. Mr. Martin will continue as manager of the sales department.

DAY & ZIMMERMANN ENGINEERING & CONSTRUCTION COMPANY announces the removal of its Philadelphia Offices to 112 North Broad Street.

THE ROLLER-SMITH COMPANY, 233 Broadway, New York, N. Y., announces the appointment of Elliott E. Van Cleef, 53 W. Jackson Boulevard, Chicago, Ill., as its district sales agent in the Chicago territory. Michael B. Mathley, who has been connected with the Chicago office for many years, will be associated with Mr. Van Cleef.

THE CRANE PACKING COMPANY announces the removal of its New York office from 109 Broad St., to 21 Bridge Street.

IOWA PUBLIC SERVICE COMPANY, is moving its headquarters from Fort Dodge, Iowa, to Sioux City, Iowa, where it plans to combine the Iowa Public Service and Sioux City Gas & Electric offices. The Sioux City Gas & Electric Company was purchased recently from the United Gas Improvement Corporation by the Iowa Public Service Company.

ATWOOD LIMITED, Montreal Que., announces that E. George Taylor has recently joined its organization. Mr. Taylor was formerly chief field engineer and manager of the service and erection department of the Combustion Engineering Corporation, Ltd., Montreal.

F. L. SMIDTH & COMPANY have moved their New York offices from 50 Church St., to 225 Broadway.

TRADE CATALOGS

SPEED INDICATOR—The electric speed indicator for indicating the speed of rotation of any type of revolving machinery is described in Bulletin 4400, issued by the Weston Electric Instrument Corporation, of Newark, N. J., and consists of a magneto that generates a voltage directly proportional to its speed, connected to an indicating instrument calibrated in revolutions per minute, miles per hour or any other units desired. Five types of magnetos and various types of indicating instruments that may be used with them are illustrated. The bulletin also includes wiring diagrams and instructions for adjustments and maintenance.

SUPERHEATERS FOR POWER PLANTS—Bulletin T-1, just issued by the Superheater Company, 17 East 42nd St., New York City, is not only a catalog, describing and illustrating the design, construction and application of Elesco superheaters for power plants, but is also a complete treatise on the subject of superheated steam. It is profusely illustrated and shows applications of the Elesco superheater to practically all types of boilers including certain applications of the radiant type superheater. An eight-page appendix, reprinted in part from "Superheat Engineering Data," gives much valuable information on the subject of superheated steam.

MULTI-STAGE CENTRIFUGAL PUMPS—The Pennsylvania Pump & Compressor Company, Easton, Pa., has issued bulletin No. 212, describing its Class OMS multi-stage centrifugal pumps adaptable to most any service and for pressures up to 1,600 lb. Several views of the pump disassembled, and cross-sections, show the details and constructional features.

ACETYLENE GENERATOR—The Oxweld Acetylene Company has published a small booklet describing the low-pressure "Carbic" generator for producing low-pressure acetylene for welding and cutting. The generator is charged with Carbic cakes, which are calcium carbide compressed into cylindrical cakes.

OIL TESTING—In a four-page pamphlet, GEA-832, the General Electric Company describes a portable oil testing set for determining the dielectric strength of oil used in oil-insulated apparatus.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35@$2.50
Kanawha	Columbus	1.25@ 1.60
Smokeless	Cincinnati	2.00@ 2.25
Smokeless	Chicago	1.75@ 2.00
S. E. Kentucky	Chicago	1.30@ 1.60
Steam	Pittsburgh	1.40@ 1.80
Gas Slack	Pittsburgh	1.10@ 1.20
Big Seam	Birmingham	1.25@ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.50@$3.00
Birdseye	New York	1.60

FUEL OIL

New York—Aug. 2, f.o.b. Bayonne, N. J.: 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 7c. per gal.

St. Louis—July 22, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.35 per bbl.; 26@28 deg., $1.40 per bbl.; 28@30 deg., $1.45 per bbl.; 30@32 deg., $1.50 per bbl.; 32@36 deg., gas oil, 4.15c. per gal.; 38@40 deg., 4.98c. per gal.

Pittsburgh—July 17, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., 5¾c. per gal.

Philadelphia—Aug. 2, 26@30 deg., $2.00@$2.07 per bbl.; 13@19 deg., $1.05 @$1.12 per bbl.; 22 plus, $1.48@$1.55 per bbl.; 27@30 deg., $2.10@$2.17 per bbl.

Cincinnati—July 31, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—July 28, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.: 22@26 deg., 57½@60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 90c. per bbl.

Boston—July 28, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5½c. per gal.

Dallas—July 28, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles—United Pacific Securities Co., 2504 West 7th St., will build a 12 story apartment building at Wilshire Blvd. and Commonwealth Ave. Estimated cost $1,000,000. Work will be done by day labor.

Conn., New Britain — City appropriated $1,250,000 and will soon take bids for the construction of a filtration plant, reservoirs, pumping equipment, etc.

Ill., Chicago—Briar Tower Building Corp., c/o Oman & Lillienthal, 431 North Michigan Ave., Archts., is having plans prepared for a 20 story apartment building at 413-423 Briar Pl. Estimated cost $2,100,000.

Ill., Chicago—General Electric Co., 230 South Clark St., will soon award contract for the construction of a warehouse and service building at Ashland Ave. and Pershing Rd. Graham, Anderson, Probst & White, 80 East Jackson Blvd., are architects.

Ill., Chicago — A. N. Rebori, 332 South Michigan Ave., Archt., will soon receive bids for a 25 story office and stores building at 125-135 West Wacker Dr., for J. M. Patterson, 431 North Michigan Ave. Estimated cost $2,000,000. Holabird & Root, 333 North Michigan Ave., are associate architects.

Ia., Indianola—City voted $25,000 bonds for rebuilding electric light plant. Dougher, Rich & Woodburn, 806 Valley National Bank Bldg., Des Moines, are engineers.

Miss., Biloxi — Anticich Packing Co., awarded contract for the construction of an ice plant to Manuel & Wetzel. Estimated cost $65,000.

Mo., Bismarck—City plans an election Sept. 11 to vote $47,000 for waterworks improvements including deep well, pump house, pumping equipment, tank on tower, etc. Russell & Axon, 1945 Railway Exchange Bldg., St. Louis, are engineers.

Mo., Perryville—City awarded contract for waterworks improvements including water filtration plant, distribution system, pumping equipment, etc. to Merkle Contracting Co., 413 City Bank Bldg., Kansas City. Estimated cost $120,000.

Mo., St. Louis—Meyer Finkelstein, et al, 800 Washington Ave., awarded contract for a 20 story apartment building at Lindell Blvd. and Taylor Ave., to J. W. Kopman Construction Co., 4525 Lindell Blvd. Estimated cost $1,900,000. Steam heating system, etc., will be installed.

N. J., Newark—H. R. Van Duyne Inc., 79 Broad St., is having plans prepared for a 5 story apartment building including steam heating and refrigeration systems, boilers, elevators, etc., at Parkview Terrace and Chancellor Ave. to Deakman Wells Co., 921 Bergen Ave., Jersey City. Estimated cost $500,000.

N. J., Radburn (Paterson P. O.)—City Housing Corp., A. Bing, Pres., 18 East 48th St., New York, is receiving bids for the construction of an apartment building, etc., including steam heating system, etc. Estimated cost $1,000,000. C. E. Stein, H. Wright, R. Kohn and F. Ackerman, 56 West 45th St., New York, N. Y., are architects.

N. Y., Buffalo—Buffalo Cold Storage Co., 78 Perry St., awarded contract for the construction of a cold storage plant at 101 Columbia St., to Hydro Construction Co., Mutual Life Bldg. Estimated cost $60,000.

N. Y., Collins—Dept. of Standards & Purchases, Erie County, F. R. Utter, Supt., will receive bids until Aug. 27 for the construction of a driven well, pump house, pump, etc. for Thomas Indian School, Iroquois.

N. Y., New York—Caul Realty Corp., H. E. Murray, Pres., 25 West 43rd St., will receive bids about Sept. 1 for a 15 story apartment building at 96 Central Park W. Estimated cost $1,600,000. Schwartz & Gross, 347 5th Ave., are architects.

N. Y., New York—Master Building Inc., L. Levy Horch, Pres., 310 Riverside Dr., awarded contract for a 24 story hotel, etc. to Longacre Engineering & Construction Co., 345 Madison Ave. Estimated cost $1,700,000.

N. C., Henderson — Virginia-Carolina Power Co., M. Smithey, Atty., Richmond, Va., plans the construction of two large power dams on the Roanoke River near here, one located at Buggs Island and the other some 20 or 25 miles down the stream. Estimated cost approximately $14,000,000.

N. C., Rocky Mount — City will soon award contract for a new generating unit addition to municipal power plant. W. C. Olsen & Co., Raleigh Building & Loan Bldg., Raleigh, are engineers.

Okla., Luther—J. C. Harrison, Stroud, is having preliminary plans prepared for the construction of a 300 hp. electric light plant and distribution system here. Estimated cost $45,000. Private plans.

Pa., Philadelphia — Philadelphia Steam Heating Corp., E. H. Reuss, Jr., Pres., 30th and Race Sts., plans the construction of a power house, 10,000 hp. capacity, at 328 Market Sts. P. H. Johnson, Weidener Bldg., is engineer.

Tex., Brownsville—Water Improvement Dist. 6, Comeron County, awarded contract for the construction of a pumping unit, 36,000 gal. capacity including 36 in. pump, 150 hp. electric motor, etc. at Villa Neva near here, to Dayton-Dowd Co., 365 York St., Quincy, Ill. Estimated cost $30,000.

Tex., Dallas—Titche-Goettinger Co., Main and Ervay Sts., will receive bids about Aug. 1 for the construction of an 8 story department store on Elm St. Estimated cost $1,500,000. H. M. Greene & Co., Construction Industrial Bldg., are architects.

Tex., San Antonio—J. M. Nix, c/o Lanier Hotel, is having revised plans prepared for an 18 story office and garage including circulating ice water system, elevators, etc. at Navarro and College Sts. Estimated cost $2,000,000. H. T. Phelps, Hicks Bldg., is architect.

Ont., Toronto—Famous Players Canadian Corp., Royal Bank Bldg., plans the construction of a theatre building including steam heating and ventilation systems, etc. at Yonge and Hayter Sts. Estimated cost $1,500,000. T. W. Lamb, 644 Eighth Ave., New York, N. Y., is architect.

Equipment Wanted

Electrical Equipment—Bd. of Public Affairs, Frankfort, O., D. F. Briggs, Jr., Clk., will receive bids until Aug. 22 for electrical equipment including 75 hp., 300 r.p.m. Fairbanks-Morse vertical engine; 5 kw. 1,400 r.p.m. Fairbanks-Morse compound wound generator; single phase 900 r.p.m. amp. 77.2, 1,100 v. Bullock generator; 1,480 r.p.m. d.c. Westinghouse generator; centrifugal water pump for cooling water for engine, air compressor, transformers, switchboard, etc.

Engine, Pump, Motor, Etc.—Mayor and Bd. of Aldermen, Kaplan, La., will receive bids until Aug. 14 for machinery and equipment including 200 hp. Diesel oil engine, 500 g.p.m. underwriters fire pump, 2,200 v., 3 ph., 60 cycle slip ring motor with starter, etc., for municipal electric light and water plant.

Power House Equipment — U. S. Engineer Office, P. O. Box 72, Louisville, Ky., will receive bids until Aug. 9 for furnishing and installing equipment in power house and turbine pit.

Pumping Units — City of Dallas, Tex., postponed taking of bids to be opened Aug. 10 for two 15 m.g.p.d. turbine driven pumping units complete with auxiliaries, three 15 m.g.p.d. motor driven pumping units complete with motors, two 507 kva. turbo-generators complete with auxiliaries and three 300 hp. watr tube boilers.

Pumps—A. L. Flint, General Purchasing Officer of the Panama Canal, Washington, D. C., will receive bids until Aug. 10 for motor driven pumps, etc.

Stokers—City of Clarksdale, Miss., J. P. Agnew, Supt., plans the installation of two 550 hp. single retort underfeed Westinghouse stokers for proposed improvements to power plant.

Industrial Projects

Calif., Los Angeles—FURNITURE FACTORY—Kittenger Co. of Buffalo, 1893 Elmwood Ave., Buffalo, N. Y., is having preliminary plans prepared for a 1 and 2 story factory and office at Industrial St. between 9th and Telegraph Rds. Estimated cost $500,000. Private plans.

Conn., Norwalk—HAT FACTORY—Sunfast Hats Inc., will soon award contract for a 3 story, 200 x 300 ft. factory on Rowan St. Estimated cost $500,000. Fletcher-Thompson Inc., 542 Fairfield Ave., Bridgeport, are architects.

Ill., East St. Louis—AIRPLANE FACTORY—Parks Airlines Inc., Missouri Theatre Bldg., St. Louis, Mo., is having preliminary plans prepared for a 1 story, 200 x 850 ft. factory here. Estimated cost $500,000. Architect and engineer not selected.

Ind., Summitville—CHEESE FACTORY—Kraft Cheese Co., plans the construction of a factory including refrigeration plant.

Mass., Boston—FACTORY AND AUTO SERVICE BUILDING—Packard Motor Car Co., East Grand Blvd., Detroit, Mich., will soon award contract for a 1 and 2 story, 70 x 108 and 90 x 108 ft. factory and auto service building here. Estimated cost $70,000. A. Kahn, 1000 Marquette Bldg., Detroit, Mich., is architect.

Mass., Canton—FACTORY—Edison Electric Illuminating Co., 39 Boylston St., Boston, awarded contract for a 2 story addition to factory here, to Reynolds Bros. Inc., 179 Summer St., Boston. Estimated cost $40,000.

Mich., Detroit — TOOL FACTORY—Gorham Tool Co., 2206 12th St., will soon award contract for a 2 story, 60 x 60 and 60 x 68 ft. factory on Woodrow Wilson Ave. Lane Davenport & Peterson, 1007 Charlevoit Bldg., are architects.

Mich., Detroit — AUTO FACTORY — Graham Paige Motor Car Co., 8505 West Warren Ave., awarded contract for a group of buildings for automobile factory to M. J. Hoffman Construction Co., 7147 West Warren Ave.

Mich., Lansing — STEEL WHEEL PLANT—Motor Wheel Corp., 701 East Saginaw St., awarded contract for a 1 story, 74 x 460 ft. factory to George Hagameir, 214 West Lapeer St.

Mo., St. Louis—CUTTING MACHINE FACTORY—Universal Cutter Co., 4567 Scott Ave., awarded contract for a 2 story, 55 x 115 and 55 x 105 ft. factory for the manufacture of electric cloth cutting machines at Skinker and Clemens Sts. to Woermann Construction Co., Syndicate Trust Bldg. Estimated cost $60,000.

N. Y., Brooklyn—STORAGE BUILDING and DISTRIBUTION CENTER—New York Dock Co., awarded contract for the construction of a 10 story warehouse and distribution center at Joralemon and Furman Sts., to White Construction Co., 95 Madison Ave., New York. Estimated cost $2,218,000.

O., Cleveland—AXLE and SPRING FACTORY—Eaton Axle & Spring Co., East 65th St. and Central Ave., awarded contract for a 1 story, 121 x 343 ft. factory and 35 x 62 ft. boiler house addition at 739 East 140th St., to The Dresser Co., Superior Arcade. Estimated cost $150,000.

O., Cleveland — FOUNDRY SUPPLY FACTORY—Federal Foundry & Supply Co., L. H. Hart, Secy. and Mgr., 2639 East 79th St., awarded contract for a 1 story, 90 x 260 ft. factory on East 71st St. to Bolton-Pratt Construction Co., 7113 Euclid Ave. Estimated cost $125,000.

W. Va., Clarksburg—CUTTING ROOM ADDITION — Pittsburgh Plate Glass Co., Frick Bldg., Pittsburgh, Pa., will build a 4 story, 50 x 400 ft. addition to cutting room here. Estimated cost $150,000. Work will be done by separate contracts.